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The Effective Research-Based Characteristics Of Professional Development And How They Relate To The National Science Foundation's GK-12 Program

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The Effective Research-Based Characteristics Of Professional Development And How They Relate To The National Science Foundation's GK-12 Program

by

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Dedication

This dissertation is dedicated to my mother, father, and brother.

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The Effective Research-Based Characteristics Of Professional Development And How They Relate To The National Science Foundation's GK-12 Program

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This mixed methods study investigates the effective research-based characteristics of professional development and the National Science Foundation's GK-12 Program. A comprehensive search of texts containing effective research-based characteristics of professional development linked to student achievement and teacher behavior provided the data to perform three content analyses. After rigorous inter- and intra-reliability testing, the content analyses yielded 16 effective research-based characteristics of professional development. For reasons of validity, the characteristics were sent to experts of professional development who were later interviewed. The characteristics were then used to deductively investigate the GK-12 program; an NSF funded professional development program that supports graduate students and advanced undergraduates in science, technology, engineering, and mathematics and partners them with cooperating

teachers in the K-12 classroom. Final evaluations from 26 of 31 GK-12 sites from the program's inception year in 1999 were analyzed in a third content analysis. The results of the analysis demonstrate that the GK-12 program incorporates all of the effective research-based characteristics of professional development, but to drastically varying degrees. Two emergent characteristics were also derived from the third analysis and included "improves communication skills" and "has real world application". Implications of the study posit that educational leaders need to be aware that effective research-based characteristics of professional development that are linked to student learning exist, and should be used to guide professional development endeavors.

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Chapter 1

Introduction

In 1983, *A Nation At Risk* (National Commission on Excellence in Education, 1983) focused attention on what Americans believed to be an inadequate educational system. Other countries were believed to have educationally surpassed the United States, and drastic changes needed to be made. Although *A Nation At Risk* was ultimately determined to be a tool of political ideology, the document became the impetus for an educational reform movement which focused on improving student learning and reshaping structure and organization in schools (Sparks & Hirsch, 2000). Stakeholders in education believed that professional development which deepened the knowledge and skills of professionals (U.S. Department of Education, 1999) would be an obvious strategy to remedy the educational system's perceived deficiencies in student learning.

Since the publication of *A Nation At Risk*, professional development has become a standard in schools, and has varied in both name and appearance. It has been called in-service, teacher training, staff development, workshop, and professional development (Tinoca, 2004), and its names are outnumbered only by its appearances and structures. For example, sometimes professional development takes the appearance of a one-day workshop where teachers are lectured on how to implement various teaching strategies. Sometimes it is based on collaboration with scientists in the field, and sometimes it is training on how to use Scantron machines.

For years, schools used professional development and assumed that the programs would ultimately impact student learning. When participants' reactions or learning were positive, it was assumed that that the enrichment of student learning occurred. When educational researchers started to conduct studies of professional development programs, they could not show evidence of student learning (Corcoran, 1995; Newmann, King & Youngs, 2000; Guskey, 2003b). The strategy to enrich student learning with professional development was not as obvious as it first seemed, and professional development designers and implementers became frustrated. The problem with professional development has been not that it could not improve student learning, but that the program designs were based on anecdotal ideas, shallow understandings of learning, poor evaluation techniques, and unclear goals (Sparks, 2000). Additionally, the U.S. Education Department and other government agencies, such as the National Science Foundation (NSF hereafter), were funding many of these professional development initiatives with large grants. There was public outcry that these programs were once again throwing tax dollars into the black hole of public education where results never materialize (U.S. Department of Education, 1995).

To remedy the problems of professional development programs, researchers (e.g., Loucks-Horsley), research agencies (e.g., Educational Research Service and Educational Testing Service), teacher associations (e.g., American Federation of Teachers), national education organizations (e.g., The National Partnership for Excellence and Accountability in Teaching), and the U.S. Department of Education (Guskey, 2003b) began to publish lists that described effective characteristics of professional development. It was believed that these lists would guide educational leaders in their professional

development endeavors. When researchers (e.g., Guskey) studied some of the lists, it was apparent that the effective characteristics of professional development did not always align and sometimes even contradicted one other. Other issues with the lists included lack of research-based evidence and poor or nonexistent connections to student learning (Guskey, 2003b).

One heavily funded, present-day, reform-based professional development project is NSF's GK-12 Program (GK-12 hereafter). NSF has funded professional development for teachers since the 1950s. These programs included the Systemic Initiatives, Rural Initiatives, and the content programs of the 1960s. GK-12 began in 1999 and today funds more than 100 sites. These sites are institutions of higher learning which collaborate with local school districts in order to put science, technology, engineering and mathematics, (STEM hereafter) graduates and advanced undergraduates in the K-12 classroom with teachers. GK-12 allows its principal investigators (PIs hereafter) to design and implement professional development activities that reflect the goals of the program which are to improve teachers' content knowledge, among other outcomes. At the end of each cycle of the program, PIs are asked to submit an evaluation of their program and address whether they have attained the prescribed goals and outcomes of the program (Currently, PIs are asked to hire an independent external evaluator to assess the program, but in 1999 this was not the case).

Rationale

There is a need for descriptions of ERBCPD linked to student learning and teacher behavior. These descriptions are important because: (a) educational leaders who design, implement, and evaluate professional development need a reliable and clear research-based guide for their programs; (b) professional development and professional development research needs to move toward an emphasis on student learning as the ultimate goal; (c) stakeholders in reform-based professional development programs such as GK-12 should be aware that research describing effective professional development exists and is necessary for success and to address today's reform-based philosophies.

The Relationship between Teacher and Student Learning.

To enrich student learning, teachers' classroom practices must change (Guskey, 1986, 2000). Guskey (1986, 2000) created a model of how professional development improves student learning outcomes by changes in teachers' classroom practices (see Figure 1.1). The process model starts with professional development which changes teacher classroom practices, which changes student learning outcomes. Many studies support the notion that professional development can cause changes in teachers' classroom practice (Crandall, 1983; Loucks-Horsley, 2003; Speck & Knipe, 2000).

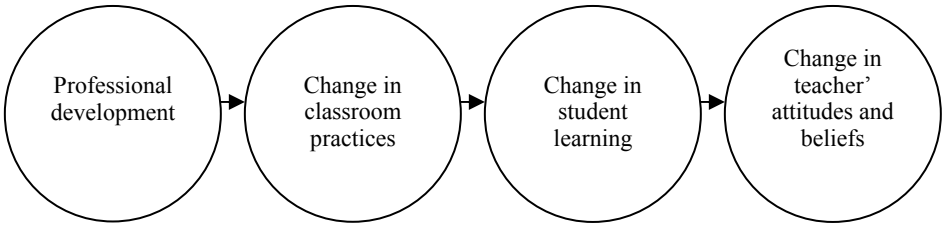


Figure 1.1: Model of Teacher Change (Guskey, 1986, 2000)

Barufaldi's (2006) model illustrates the complex dynamics of a professional development system (see Figure 1.2). The model is centered on the student, which informs and influences the program, facilitator or educational leader, and the teacher. The teacher, educational leader, and program can then address the needs of the student within certain social, political, and economic domains.

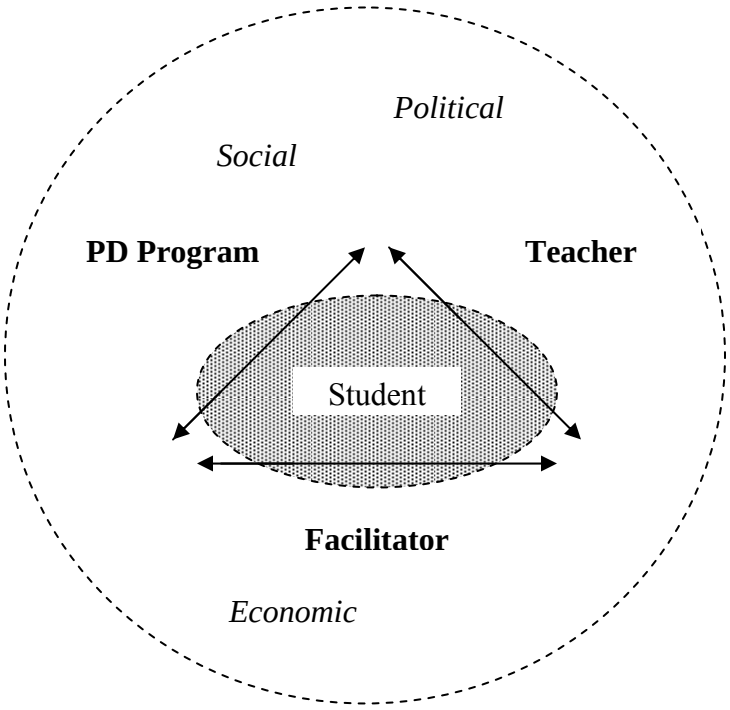


Figure 1.2: Components of a Dynamic Professional Development System (Barufaldi, 2006)

To change teachers' classroom practice by professional development, educational leaders must ask themselves how teachers learn. Currently, there is not much research on

how teachers learn, but it is assumed that teacher learning is very similar to student learning (NRC, 2000). Bransford and the Cognition and Technology Group at Vanderbilt (1998) have created a model for learner centered environments similar to professional development. The model is based on current research in cognition and learning theory and stresses attention on learners' current knowledge, skills, attitudes, and beliefs. The model is built on needs, interests, and strengths of the learner.

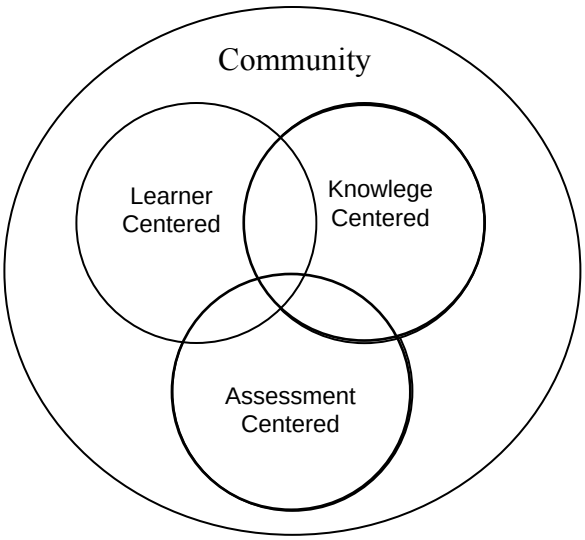


Figure 1.3: Perspectives on Learning Environments (Bransford et al., 1998)

Bransford et al.'s learner centered model (see Figure 1.3) is far removed from the typical professional development experience. Most professional development endeavors lack participation of teachers (Radford, 1999), are disconnected from the learning experience (O'Brien, 1992), and use ineffective lectured-based methods (Tinoca, 2004). The reason that many professional development experiences fail to enrich teacher

learning (NRC, 2000) is because they do not address teachers' needs (Barufaldi, 1987; Feldman & Kropf, 1997). When teachers' needs are met, professional development becomes meaningful and effective (Lieberman & Miller, 1999). Speck and Knipe (2005) state that teachers should also be involved in planning, implementing, reviewing, revising, and evaluating professional development.

Problem

The problem is that educational leaders need descriptions of ERBCPD (Speck & Knipe, 2005) in order to guide their programs toward student learning. There is a large body of literature describing effective professional development, but little high-quality research that connects ERBCPD to changes in student learning and teacher behaviors (U.S. Department of Education, 1999). To complicate matters further, some lists and studies of effective characteristics contradict each other (Guskey, 2003b), and there is not a consensus among professional development researchers for "effectiveness" (Guskey, 2003a). These central issues lead to confusion for educational leaders who design, implement and evaluate professional development (Guskey, 2000b). The disagreement may be due to the fact that many of lists are not research-based, many do not describe what measurement or evidence was used to establish characteristics, and many have not based their characteristics on the goal of student learning and teacher behavior. Other inherent reasons for differences maybe difficulty in controlling variables and accounting for complex interactions of the social world, and the inevitable influences of researchers' values and beliefs.

One example of a program that may benefit from ERBCPD is GK-12. The program allows its site PIs to design, implement, and evaluate their respective programs. The PIs are typically full professors in STEM, with little or no background in professional development. Additionally, very little research has been conducted on the effective research-based characteristics of GK-12; therefore, it is necessary to investigate the program to understand how and if it is fulfilling its goals, and how it aligns with ERBCPD.

The many texts that describe effective professional development have very similar characteristics despite their lack of consensus.

Purpose of Study

Effective Research-Based Characteristics of Professional Development

The purpose of this study was to create descriptions of ERBCPD, and to use these descriptions to investigate ERBCPD of the GK-12 program. According to Guskey (1997), ERBCPD are elusive and a consensus of these characteristics needs to be reached.

Researchers, research agencies, national education organizations, teacher associations, and the U.S. Department of Education have published lists of effective characteristics of professional development. Many of these lists were created to address reform-based philosophies by aiding educational leaders in design, implementation, and evaluation of professional development. Table 1.1 lists nineteen works that describe effective characteristics of professional development. The lists have been cross-

referenced by broad, content-specific categories created by Guskey and two other colleagues (2000b). An examination of the table shows a lack of consistency in the lists' characteristics. For example, according to Garet, Porter, Desimone, Birman, and Yoon (2001), the strongest effective characteristics of professional development is a variety of forms. However, this characteristic is mentioned in only four out of the twenty other studies. If the characteristic is important, it would make sense that it would be mentioned in other studies as well.

Contradictions also exist between some of the lists' characteristics. For example, many of the works claim that sufficient time should be provide for effective professional development (Guskey, 2003a). Kent (2000) states that time for professional learning should be provided for it to occur in a meaningful manner. But Kennedy (1998) and Weglinsky (2002) argue that differences in time were not related to achievement. Another issue with the lists is that they are not all research-based. Many of the lists do not describe what measurement or evidence was used to establish the characteristic. The last issue is that many of the lists do not include student learning as one of its goals for professional development. Most lists focus on teacher effectiveness, while others do not mention a goal.

GK-12 Program

The NSF's GK-12 program enables graduate students and advanced undergraduates in STEM, through fellowships and associated training, to partner with cooperating teachers in K-12 schools (NSF, 2004). The expected project outcomes are: (a) improved teaching, communication, and team-building skills for Fellows; (b)

professional development opportunities and content gains for GK-12 teachers; (c) learning for K-12 students; (d) incorporation of GK-12 activities as an integral part of the institution's graduate programs in STEM; (e) new and improved partnerships between local school districts and higher education institutions, and (f) improvement of graduate education through activities and project outcomes (NSF, 2005). Higher education institutions apply for awards to support activities and are responsible for: (a) selecting Fellows and teachers; (b) collaborating with school districts for placement of Fellows in schools; (c) providing professional development for Fellows; and (d) designing and implementing an effective evaluation for outcomes (NSF, 2004).

There has been little published material on GK-12 (Gilmer, Granger, & Butler, 2005). A careful examination of the Education Resources Information Center (ERIC), Education Full Text, Professional Development Collection, ProQuest Digital Dissertation, and Google Scholar revealed minimal work on the program. The most relevant works found were evaluation reports by Mitchell, Levine, Gonzalez, Bitter, Webb, and White (2003) and Williams (2002); conference papers by Balinsky, Gilmore, and Davis (2006), Brown (2006), Ferreria (2006), Huziak, Van Hook, Nurnberger-Haag, and Ballone-Duran (2006), Thompson and Lyons (2006), and Thompson, Metzgar, Collins, Joeston, and Shepherd (2002a); an article by Thompson, Collins, Metzgar, Joeston and Shepherd (2002b); and a monograph by Gilmer et al. (2005).

Table 1.1: Effective Research-Based Characteristics of Professional Development Matrix

Characteristics (adapted from Guskey, 2003b)	American Federation of Teachers (1996)	Corcoran (1995)	U.S. Department of Education (1997)	Kent, K., & Lingman, C. (2000)	National Partnership for Excellence and Accountability in Teaching. (2000)	Wenglinsky, H. (2002)	Loucks-Horsley, S., Stiles, K., & Hewson, P. (2003)	National Staff Development Council (2001)	Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001)	Tinoca (2004)	National Science Education Standards (NRC, 1996a)	Commission on Life Sciences (NRC,1996b)	Speck & Knipe (2005)	Sparks (2002)	Darling-Hammond (1997a)	Hawley & Valli (1996)	Educational Research Service (1998)	Center for Performance Assessment (2005)	Association for Supervision and Curriculum Development (2002)
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s
Research-based (y/n)	*y*	*y*	*y*	*y*	*y*	*y*	*y*	*y*	*y*	*y*	*y*	*y*	*y*	*y*	*y*	*y*	*y*	*n*	*n*
Enhances teachers' content and pedagogic knowledge	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Provides sufficient time and other resources	x	x	x	x		x		x	x	x			x	x			x		
Promotes collegiality and collaboration		x	x	x	x		x	x	x	x	x	x	x	x	x	x		x	x
Includes procedures or evaluation	x		x	x	x		x	x				x	x				x	x	
Aligns with other reform initiatives			x	x	x		x	x	x	x	x		x			x	x		x
Models high-quality instruction	x	x		x			x	x	x				x						
Is school or site based		x			x									x		x	x		x
Builds leadership capacity			x	x			x					x					x	x	
Based on teachers' identified needs	x	x			x			x					x	x	x	x	x		x
Driven by analyses of student learning data				x	x			x		x			x			x	x	x	

Table 1.1: Effective Research-Based Characteristics of Professional Development Matrix (Continued)

Characteristics (adapted from Guskey, 2003b)	American Federation of Teachers (1996)	Corcoran (1995)	U.S. Department of Education (1997)	Kent, K., & Lingman, C. (2000)	National Partnership for Excellence and Accountability in Teaching. (2000)	Wenglinsky, H. (2002)	Loucks-Horsley, S., Stiles, K., & Hewson, P. (2003)	National Staff Development Council (2001)	Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001)	Tinoca (2004)	National Science Education Standards (NRC, 1996a)	Commission on Life Sciences (NRC, 1996b)	Speck & Knipe (2005)	Sparks (2002)	Darling-Hammond (1997a)	Hawley & Valli (1996)	Educational Research Service (1998)	Center for Performance Assessment (2005)	Association for Supervision and Curriculum Development (2002)
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s
Focuses on individual and organizational improvement	x	x	x	x								x			x	x	x		
Includes follow up and support		x			x										x	x	x		
Is ongoing and job embedded		x	x					x					x	x	x	x	x		x
Helps accommodate diversity and promote equity						x							x				x		
Based on best available research evidence	x		x				x	x			x							x	
Takes a variety of forms	x								x				x						x
Provides opportunities for theoretical understanding					x									x		x			
Driven by an image of effective teaching and learning							x				x		x					x	
Provides for different phases of change												x				x	x		
Promotes continuous inquiry and reflection					x						x	x	x	x	x				x
Involves families and other stakeholders								x			x								

Although some successful characteristics are shared between the studies, it is important to find to what degree these characteristics overlap, which characteristics appear most, and why some characteristics are reported by some but not others. It is also important to investigate how the characteristics are related to evaluation in student learning and teacher behavior. For example, only Huziak et al. (2006), Thompson et al. (2002a), and Thompson and Lyons (2006) reported benefits to students. Huziak et al. (2006) and Thompson et al.'s (2002a) benefits were reported by the Fellows and others, not via student scores. Thompson and Lyons (2006) directly evaluated student learning. Lastly, it is necessary to investigate what effective research-based characteristics of GK-12 do not appear on the final descriptions of ERBCPD. These emergent characteristics might shed some light on identifying differences between professional development programs for teachers and scientists.

Research Questions

Queries into ERBCPD and the GK-12 program have raised numerous research questions. The following questions will be addressed in this study:

1. What are the effective research-based characteristics of professional development?
2. What are the effective research-based characteristics of professional development of the GK-12 program?

3. What are effective research-based characteristics of professional development of the GK-12 program that are not answered by Question One? Why are these characteristics not mentioned?

Theoretical Foundation

A mixed methods approach will be used to answer the research questions. This approach is most appropriate because the combination of qualitative and quantitative aspects will yield a stronger analysis than a single approach. The two aspects will complement each other in order to triangulate data. A qualitative approach will be used to: (a) inductively determine ERBCPD from selected literature review lists in order to form a hypothesis, and (b) test for validity of the final ERBCPD with expert interviews. A quantitative approach will used to: (a) deductively determine the ERBCPD, and (b) test for the reliability of content analyses.

Some researchers believe that a mixed methods approach to answering research questions is problematic and often scrutinized (Barufaldi, personal communication, June 25, 2005). The major reason for this is the incompatibility thesis. This thesis states that it is inappropriate to bring together methods from different paradigms to study phenomena (Teddlie & Tashakkori, 2003). This is because the two major paradigms, positivism and constructivism (see definitions on page 19) have dualistic ontologies, epistemologies, and methods, and are therefore believed to be incompatible in the same study (Smith & Heshusius, 1986).

Mixed methods studies first emerged in the 1960s in psychology. A few of these studies had major impacts in the field and include Sherif, Harvey, White, Hood, and Sherif's Cave Experiment (1961), and Zimbardo's (1969) simulated prison experiment (Teddlie & Tashakkori, 2003). The argument for a mixed methods approach was furthered by Denizen (1978) who introduced the notion of *triangulation*; the use of multiple data sources and/or methods to answer a research question. Denizen's triangulation differed from the natural sciences' triangulation because it could be used to study the same phenomenon within dualistic ontologies. Howe (1988) posited a new paradigm that would align with the ontologies, epistemologies, and methods of the mixed method approach. This new paradigm, to those who study mixed methods, is referred to as *pragmatism*. The philosophy of pragmatism, an American invention, is basically a practical application to answering research questions. This means that knowledge is determined by what works out most effectively and not a search for positivistic truth (Rescher, 1995). Howe (1988) states that pragmatists should avoid the use of concepts such as "truth" and "reality". Pragmatists make do with information needed to describe practice; therefore they are more concerned with the research question at hand, versus methods or paradigms (Teddlie & Tashakkori, 2003). There are three major types of pragmatism; Piercian, Jamesian, and Deweyian. The work of this study most closely aligns with the work of Charles Sanders Pierce. Pierce, the father of pragmatism, posited that "the practice issue is that of scientific praxis and the standard of efficacy pivoted on the issue of specifically predictive success" (Hartshorne, Weiss, & Burks, 1958). According to Teddlie and Tashakkori (2003), the incompatibility thesis has been largely

discredited because mixed methods have been shown to be predictive, successful, practical, and have the ability to answer research questions such as those in this study.

Limitations of the Study

A limitation of this study is that all the lists are not entirely linked to student learning. A link to student learning would be ideal since the main purpose of professional development is to enrich student learning (Joyce & Showers, 1995; Speck & Knipe, 2005). Since most of lists do not mainly address student learning to evaluate professional development, the second best form of evaluation, teacher behavior, will also be used (Guskey, 2005). All lists must have provided at least one component of student learning and/or teacher behavior evaluation to be used. Lists that are based on a research synthesis had to have at least one study that provided at least one component of student learning and/or teacher behavior evaluation to be included in the analysis. Most of the lists are linked to weaker forms of evaluation such as participant reactions to professional development. If this researcher were to use only lists that were mainly linked to student learning, only four or five lists could be used in the analysis.

Another limitation of this study is that the descriptions of ERBCPD, like any description, will reduce information for parsimony's sake. Anytime observation and experimentation are reduced, the contexts of situations may be lost. For example, if one of the characteristics is to promote equity (i.e. Weglinsky, 2002), then schools with homogeneous populations may not need to address this ERBCPD.

One major limitation of this study is that all of the GK-12 evaluations were not conducted and written by external evaluators, but by the PIs and/or those within the PI's institution. This may be an obvious bias because the evaluators were invested in the program and were more likely to write and submit an evaluation that painted a favorable portrait of the program. Another problem with the evaluations is that they may have been completed by those with little or no background in either the social sciences or evaluation (this includes PIs). This may lead to weak use of instrumentation and/or poor methodology.

Another limitation of the study is the focus on student learning through measurement. This is problematic because learning is defined, in this study, as a function of student achievement, performance, and learning outcome. This is the most practical way to assess learning, despite cognitive and learning research and theory which support qualitative forms of assessment and evaluation.

The last limitation of the study is the assumption that professional development affects teachers and Fellows in a similar manner. Little research has been done investigating how professional development affects Fellows. It will be assumed that Fellows and teachers are affected similarly by professional development experiences.

Definitions of Terms

Professional Development

Professional development is the deepening of knowledge and skills of professionals, (U.S. Department of Education, 1999) through an organized program. In

the context of this study, professionals include both teachers and Fellows. The main goal of professional development is enrichment of student learning (Joyce & Showers, 1995; Speck & Knipe, 2005) and, secondarily, teacher behaviors. There are other goals of professional development, such as teacher retention, but these goals will not be addressed in this study. Professional development looks very different from place to place. The typical professional development experience entails a one-day workshop where an individual lectures to others on how to implement new teaching skills and strategies. Other forms of professional development may be years long, and ask participants to actively participate in learner-centered activities.

Student Learning

Student learning is difficult to measure and has posed a problem for educational researchers and psychometricians for years. For the purposes of this study, student learning will be defined as a function of student achievement, performance, or learning outcome. The measurements include student scores, school scores, portfolios, interviews, and questionnaires (Guskey, 2005). According to many, student learning is the bottom line of education (Guskey, 2005; Hein, 1997; Tinoca 2004).

Teacher Behavior

Teacher behavior will be defined as how teachers and Fellows use new knowledge and skills. This will be measured by questionnaire, interview, personal reflection, portfolio, or direct observation (Guskey, 2005). These measures have been

taken after the professional development experience and are much more reliable than teachers' and Fellows' learning and reactions.

Effectiveness

Effectiveness is the most difficult term to define in the professional development literature because its meaning differs with each study. Effectiveness will be defined as having the potential, based on research-based evidence and measurement, of enriching student learning or teacher behavior.

Teachers

In the professional development portion of the study, teachers were those who were responsible for student learning in the K-12 classroom, and attend professional development. For the GK-12 portion of the study, the Fellows were considered teachers since they are responsible for student learning in the K-12 classroom, and attend GK-12 activities.

Educational Leaders

Those who design, implement, and sometimes evaluate professional development. This includes GK-12 PIs.

Positivism

Positivism is an example of a paradigm, or a basic set of beliefs that guide and constrain action in any study (Denzin & Lincoln, 1998). Positivism uses internal validity,

external validity, reliability, and objectivism for disciplined inquiry (Denzin & Lincoln, 1998). The positivistic paradigm has been criticized for its inability to solve social issues, despites its powerful history in the natural sciences.

Constructivism

Constructivism is a paradigm and is based on a relativistic ontology which contrasts with positivism. Inquiry in constructivism is centered on the production of reconstructed understandings, and positivistic internal and external validity is replaced with trustworthiness and authenticity (Denzin & Lincoln, 1998).

Organization of Dissertation

This chapter presented an introduction to professional development, its relationship to reform, its failure to enrich student learning, and its elusive effective characteristics. The introduction also addresses NSF's professional development program known as GK-12. Lastly, the problem, rationale, purpose, definitions and research questions address the ERBCPD and GK-12.

Chapter Two is a literature review of the texts and lists that describe the ERBCPD. The lists are presented verbatim when applicable. Level of evaluation, GK-12, and GK-12 studies are also addressed. Chapter Three describes the mixed methodology and paradigm that was used. This includes three content analyses, expert interviews, and additional literature reviews.

Chapter Four presents the findings of the study, and answers the research questions. Findings are presented in both qualitative and quantitative forms. Chapter Five addresses the ERBCPD descriptions, the implications of the study, the reasons for emergent characteristics not accounted for in the ERBCPD and ideas for further research.. A separate but related section revisits the rationale for the study, and addresses ERBCPD, how it should be used, and its place in postmodern society.

Chapter 2

Review of Literature

Introduction

The following is a comprehensive review of lists, studies, and books that focus or describe effective characteristics of professional development . The works have been summarized and the characteristics, when applicable, have been presented verbatim. Each summary addresses the nature of the study (e.g., empirical data, research synthesis, etc.), and the characteristics. The second section of the review summarizes work on professional development evaluation, the GK-12 program, and evaluations of the GK-12 program.

Many of the lists and studies presented in this study were investigated by Guskey (2003b). He reviewed the best-known lists from researchers, research agencies, teacher associations, educational organizations, and the U.S. Department of Education. He compared the lists' effective characteristics in order to establish whether a consensus existed between the lists, how the lists were created, and the respective goals of professional development. He found that no single characteristic was found on all lists, many lists were not research-based, and some characteristics were contradictory.

Effective Research-Based Characteristics of Professional Development

The American Federation of Teachers (2002) created a document to guide professional development programs. The document stated that professional development is essential to educational reform and improving teacher quality, and that student achievement should be the goal of professional development. The characteristics were based on teachers' views of effective professional development.

1. Professional development should deepen and broaden knowledge of content.
2. Professional development should provide a strong foundation in the pedagogy of particular disciplines.
3. Professional development should provide knowledge about the teaching and learning processes.
4. Professional development should be rooted in and reflect the best available research.
5. The content of professional development should be aligned with the standards and curricula teachers use.
6. Professional development should contribute to measurable improvement in student achievement.
7. Professional development should be intellectually engaging and address the complexity of teaching.

(American Federation of Teachers, 1996: p. 11)

Corcoran (1995), through the Consortium for Policy Research in Education, describes what is known about professional development, what its goal should be, and presents principles for effectiveness. The principles are based on a number of experts and organizations (e.g., Griffin, Hodges, Joyce and Showers, Loucks-Horsley, Little, Price, and Zimpher & Howey). Although student expectations are mentioned in the article, the goal of professional development is seen as improving teacher knowledge and skills.

1. Stimulate and support site-based initiatives

2. Support teacher initiatives as well as school or district initiatives.
3. Grounded in knowledge about teaching.
4. Model constructivist teaching.
5. Offer intellectual, social and emotional engagement with ideas, materials and colleagues.
6. Demonstrate respect for teachers as professionals and as adult learners.
7. Provide for sufficient time and follow-up support for teachers to master new content and strategies and to integrate them into their practice.

(Corcoran, 1995, Guiding principles, ¶ 1)

The U.S. Department of Education (1997) published a book called *Achieving the Goals - Goal 4: Teacher Professional Development*. The book investigates what federal agencies are doing to improve professional development. The authors claim that the goal of professional development is to improve teacher effectiveness in order to improve student learning. The characteristics are based on the ideas of experts, one being Darling-Hammond.

High-quality professional development should:

1. focus on teachers as central to student learning, yet include all other members of the school community
2. focus on individual, collegial, and organizational improvement
3. respect and nurture the intellectual and leadership capacity of teachers, principals, and other school community members
4. reflect best available research and practices in teaching, learning, and leadership
5. enable teachers to develop further expertise in subject content, teaching strategies, uses of technology, and other essential elements in teaching to high standards
6. promote continuous inquiry and improvement embedded in the daily life of schools
7. be planned collaboratively by those who will participate in and facilitate the development
8. require substantial time and other recourses
9. be driven by coherent long-term plans
10. be evaluated ultimately on the basis of its impact on teacher effectiveness and student learning, and this assessment guides subsequent professional development efforts.

(U.S. Department of Education, 1997, p. 7-8)

Kent and Lingman's work (2000) was done as part of the California Professional Development Reform Initiative. Three statewide professional development organizations worked collaboratively: the California Staff Development Council, The Center for the Future of Teaching and Learning, and the professional development unit at the California Department of Education. The committee studied a "…summary of recent professional development reports and resources, together with some key articles (Sparks, 1997; Sparks & Hirsh, 1997)." The summaries were organized around themes, and the themes were presented to teachers during interviews. Teachers were asked to comment on the themes, and the strongest themes became the characteristics listed below. In this study, the goal of professional development is student performance.

1. Uses student performance and achievement data, including student feedback, teacher observation, analysis of student work and test scores, as part of the process for individual and organizational learning.
2. Uses a coherent long-term professional development planning process, connected to the school plan, that reflects both site-based priorities and individual learning needs.
3. Provides time for professional learning to occur in a meaningful manner.
4. Respects and encourages the leadership development of teachers.
5. Develops, refines, and expands teachers' pedagogical repertoire, content knowledge, and the skill to integrate both.
6. Provides for and promotes the use of continuous inquiry and reflection.
7. Provides for collaboration and collegial work, balanced with opportunities for individual learning.
8. Follows the principles of good teaching and learning, including providing comfortable, respectful environments conducive to adult learning.
9. Creates broad-based support of professional development from all sectors of the organization and community through reciprocal processes for providing information and soliciting feedback.
10. Builds in accountability practices and evaluation of professional development programs to provide a foundation for future planning.

(Kent & Lingman, 2000, p. 34)

The National Partnership for Excellence and Accountability in Teaching (NPEAT) (2000) created a list of "research-based principles" for effective professional development. The list reflects a presentation and interviews at the 1999 Conference of Teacher Professional Development and “stories” from schools that had used learner-centered approaches to professional development (Guskey, 2003c). The goal of professional development is student learning.

1. The content of professional development focuses on what students are to learn and how to address the different problems students may have in learning the material.
2. Professional development should be based on analyses of the differences between (a) actual student performance and (b) goals and standards for student learning.
3. Professional development should involve teachers in identifying what they need to learn and in developing the learning experiences in which they will be involved.
4. Professional development should be primarily school-based and built into the day-to-day work of teaching.
5. Most professional development should be organized around collaborative problem-solving.
6. Professional development should be continuous and ongoing, involving follow-up and support for further learning – including support from sources external to the school that can provide necessary resources and new perspectives.
7. Professional development should incorporate evaluation of multiple sources of information on (a) outcomes for students and (b) the instruction and other processes involved in implementing lessons learned through professional development.
8. Professional development should provide opportunities to understand the theory underlying the knowledge and skills being learned.
9. Professional development should be connected to a comprehensive change process focused on improving student learning.

(NPEAT, 2000, p. 3)

Weglinsky (2002) used a multilevel structural equation model to study data from more than 7,000 eighth graders' 1996 National Assessment of Educational Progress mathematics test scores. Ten measures of professional development were studied: professional development in cooperative learning over the last five years, portfolio assessment, interdisciplinary instruction, higher-order thinking skills, classroom management, teaching special-needs students, performance-based assessment, cultural diversity, teaching limited-English-proficient (LEP) students, and the amount of professional development which teachers received in the previous year.

Although Weglinsky does not explicitly present a list, his study shows that professional development should:

1. address special populations of students
2. address higher-order thinking skills
3. address hands-on learning
4. address solving unique problems
5. avoid reliance on authentic assessments
6. not necessarily rely on amount of time as a factor that is related to achievement

(Weglinsky, 2002, Results, ¶ 8-9)

Loucks-Horsley, Love, Stiles, Mundry, and Hewson (2003) have created a list of characteristics for the professional development of science and mathematics teachers based on a synthesis of standards and related resources. The stated goal of professional development is to improve student learning.

Effective professional development:

1. is driven by a well-defined image of effective classroom learning and teaching.

2. provides opportunities for teachers to build their content knowledge and pedagogical knowledge, and examine practice.
3. is research-based and engages teachers as adult learners in the learning approaches they will use with their students.
4. provides opportunities for teachers to collaborate with colleagues and other experts to improve practice.
5. supports teachers to Gilmer et al. in leadership roles.
6. links to other parts of the educational system.
7. has a design based on student learning data and is continually evaluated and improved.

(Loucks-Horsley et al., 2003, p. 44)

National Staff Development Council (NSDC) is the largest non-profit organization in the country committed to student learning through professional development. The *Standards for Staff Development* (NSDC, 2001) was published in order to build a consensus in the field of professional development, and is "…grounded in research that documents the connection between staff development and student learning (NSDC, 2001, p. 2).

1. Context Standards
    a. Learning communities: Staff development that improves the learning of all students organizes adults into learning communities whose goals are aligned with those of the school and district.
    b. Leadership: Staff development that improves the learning of all students requires skillful school and district leaders who guide continuous instructional improvement.
    c. Resources: Staff development that improves the learning of all students requires resources to support adult learning and collaboration.
2. Process standards
    a. Data-driven: Staff development that improves the learning of all students uses disaggregated student data to determine adult learning priorities, monitor progress, and help sustain continuous improvement.
    b. Evaluation: Staff development that improves the learning of all students uses multiple sources of information to guide improvement and demonstrate its impact.

c. Research-based: Staff development that improves the learning of all students prepares educators to apply research to decision making.
d. Design: Staff development that improves the learning of all students uses learning strategies appropriate to the intended goal.
e. Learning: Staff development that improves the learning of all students applies knowledge about human learning and change.
f. Collaboration: Staff development that improves the learning of all students provides educators with the knowledge and skills to collaborate.

3. Content standards
    a. Equity: Staff development that improves the learning of all students prepares educators to understand and appreciate all students, create safe, orderly and supportive learning environments, and hold high expectations for their academic achievement.
    b. Quality teaching: Staff development that improves the learning of all students deepens educators' content knowledge, provides them with research-based instructional strategies to assist students in meeting rigorous academic standards, and prepares them to use various types of classroom assessment appropriately.
    c. Family involvement: Staff development that improves the learning of all students provides educators with knowledge and skills to involve families and other stakeholders appropriately.

(NSDC, 2001, p. 5)

Garet et al. (2001) sampled 1,027 elementary and secondary mathematics and science teachers in an empirical comparison of the effects of professional development characteristics on teacher learning. The teachers were participants of the Dwight D. Eisenhower Professional Development Program (EPDP), a program which focused on the development of content knowledge. Data were teachers' self-reported surveys on the effects of professional development on their learning. The authors reviewed relevant literature, used six exploratory case studies, ten in-depth case studies and survey results, and concluded that three structural and three core features had potential for effective professional development. The stated outcome of professional development is academic achievement of students.

Results…indicate three core features of professional development activities that have significant, positive effects on teachers' self-reported increases in knowledge and skills, and changes in classroom practice:

1. focus on content knowledge
2. provide opportunities for active learning
3. coherence with other learning activities.

It is primarily through these core features that the following structural features significantly affect teacher learning:

4. the form of the activity
5. collective participation of teachers from the same school, grade, or subject
6. duration of the activity.

(Garet et al., 2001, p. 915)

Tinoca (2004) conducted a meta-analysis of 37 professional development programs that reported increases in student learning. Characteristics of effective professional development were based on categories from Loucks-Horsley, the National Science Education Standards, and the researchers' analysis of other variables. The stated goal of professional development is student learning. Programs that have shown to impact student learning hold the following characteristics:

1. Emphasize work on curriculum development, replacement, or implementation.
2. Emphasize work on scientific inquiry.
3. Emphasize work on pedagogical content knowledge.
4. Last more than 6 months and with a total duration of at least 100 hours.

(Tinoca, 2004, p. viii)

The Center for Performance Assessment (CPA) is a private educational organization that works with school districts to improve student achievement through improvements in teachers' knowledge and skills. The center's website (2005) states that the effective

characteristics are based on the group's collective personal experiences. The characteristics address all disciplines, including mathematics and science. No goal of professional development is explicitly stated.

- First, there must be a clear and consistent purpose for professional development.
- Second, specific areas of knowledge and skills that are necessary for improving student achievement must be identified.
- Third, every building must have permanent resources so that the knowledge and skills of the seminars are reinforced for current faculty members and introduced to new faculty members.
- Fourth, local leadership must be encouraged and nurtured through networking with other educators and leaders who are committed to the best practices in teaching, assessment, and leadership.
- Fifth, the efforts of teachers and school leaders must be supported with a holistic accountability system that includes not only test scores, but also a comprehensive analysis of the teaching and leadership practices that are associated with improved student achievement.
- Sixth, leaders and policymakers must be supported in their efforts through direct support and access to the most recent information.
- Seventh, the motivation to put all of the pieces together is provided in the form of dynamic and research-packed keynote presentations.

(CPA, 2005, ¶ 1)

The National Science Education Standards (National Research Council [NRC], 1996a) were created to guide society toward scientific literacy. An entire chapter of the standards is devoted to professional development and its effective characteristics. The characteristics are a synthesis of a literature review, and the goal is scientific literacy for students.

1. The learning of science content through inquiry.
2. The integration of knowledge about science with knowledge about learning, pedagogy, and students.
3. The development of the understanding and ability for lifelong learning.

4. The coherence and integration of professional development programs.

(NRCa, 1996, p. 57-58)

The NRC's Commission on Life Sciences (1996b) designed a guide for scientists who are interested in creating reform-based professional development for teachers. The characteristics are based on reviews of more than 180 professional development programs for science teachers, some of which have been investigated in detail. This information along with site visits, interviews, and the authors' professional experiences and knowledge are used to define the characteristics.

1. Scientists, teachers, and administrators collaborated in the program's development and implementation.
2. Teachers were treated as professionals.
3. Program was designed to meet school-based needs.
4. Continuous involvement with staff and others.
5. Evaluation was formative and summative.
6. New partnerships, projects, and networks were stimulated among participant teachers and between teachers and scientists.
7. Program directors used effective publicity and recruitment strategies.
8. Program was encouraged and supported by school districts and administrators.
9. Effective dissemination strategies used.
10. Program directors had practical knowledge of the change process.
11. Charismatic person or group provided strong leadership.

(NRC, 1996b, p. 2)

The Association for Supervision and Curriculum Development (ASCD) is a non-profit educational organization that offers materials and workshops for schools interested in improving their professional development for any discipline. ASCD (2002) has listed seven characteristics for professional development on their website. Although it is

unclear how they came up with the characteristics, they do address the goal of professional development as student learning.

1. Directly focused on helping to achieve student learning goals and supporting student learning needs.
2. A collaborative endeavor – teachers and administrators work together in planning and implementation.
3. School-based and job-embedded.
4. A long-term commitment.
5. Differentiated.
6. Tied to the district's goals.

(ASCD, 2002, ¶ 1)

Speck and Knipe (2005) describe the content and process of high-quality professional development. The characteristics are presented as a circular framework that centers on the goal of professional development: student learning. It is based on a synthesis of research.

1. Centers on learner (engages teachers; embedded in real work; offers choices and levels of learning; employs effective strategies; has specific content and assessment; uses inquiry, dialogue, and reflection; informs work with inside and outside expertise and research).
2. Sustains growth (supports learning around practice; is sustained and intensive; expands knowledge; builds on shared knowledge and collaboration).
3. Requires resources (needs administrative support; requires leadership; allocates resources).
4. Evaluates progress toward goals (evaluates progress; evaluates impact on student learning using data).
5. Assesses needs (emerges from teachers' expressed needs; uses data to inform practice), establishes goals (plans align to goals; requires foundation of standards and accountability).

(Speck & Knipe, 2005, p. 9)

Dennis Sparks, the executive director of NSDC, has written a book (*Designing Powerful Professional Development for Teachers and Principals*, 2002) that describes high-quality professional development. The author states that effective professional development is driven by student learning, and is based on the most recent research in teaching and learning.

High-quality staff development:

1. focuses on deepening teachers' content knowledge and pedagogical skills.
2. includes opportunities for practice, research, and reflection.
3. is embedded in educators' work and takes place during the school day.
4. is sustained over time.
5. is founded on a sense of collegiality and collaboration among teachers and between teachers and principals in solving important problems related to teaching and learning.

(Sparks, 2002, p. 1-4, 1-5)

Darling-Hammond published a book titled *Right to Learn* (1997a) which lists several shared features of "professional development strategies that succeed in improving teaching" (Darling-Hammond, 1997a, p. 326). These features are:

1. Experiential, engaging teachers in concrete tasks of teaching, assessment, and observation that illuminate the process of learning and development.
2. Grounded in participants' questions, inquiry, and experimentation as well as professionwide research.
3. Collaborative, involving a sharing knowledge among educators.
4. Connected to and derived from teachers' work with their students as well as connected to examinations of subject matter and teaching methods.
5. Sustained and intensive, supported by modeling, coaching, and problem solving around specific problems of practice.
6. Connected to other aspects of school change.

(Darling-Hammond, 1997a, p. 326)

Hawley and Valli (1999) synthesized new studies and past research syntheses in order to create design principles for effective professional development. These eight characteristics are believed to "…improve student learning over time" (Hawley & Valli, 1999, p.137).

1. Driven, fundamentally, by analyses of the differences between (1) goals and standards for student learning and (2) student performance.
2. Involves learners (such as teachers) in the identification of their learning needs and, when possible, the development of the learning opportunity and/or the process to be used.
3. Is primarily school based and integral to school operations.
4. Provides learning opportunities that relate to individual needs but for the most part are organized around collaborative problem solving.
5. Is continuous and ongoing, involving follow-up and support for further learning, including support from sources external to the school.
6. Incorporates evaluation of multiple sources of information on outcomes for student and processes involves in implementing the lessons learned through professional development.
7. Provides opportunities to develop a theoretical understanding of the knowledge and skills to be learned.
8. Is integrated with a comprehensive change process that deals with the full range of impediments to facilitators of student learning

(Hawley & Valli, 1999, p.138)

The Educational Research Service (1998) has published a list of characteristics of high-quality professional development. The list draws from works by Sparks and Loucks-Housley (1989) and NSDC (1995), among others.

Characteristics of high-quality professional development:

- Is conducted in school settings and linked to schoolwide efforts.
- Encourages teachers to participate as helpers to each other and as planners, with administrators, of inservice activities.
- Emphasizes a variety of training activities.

- Involves teachers in active roles, choosing goals and activities for themselves.
- Emphasizes demonstration, supervised trials, and feedback, with concrete and continuous training.
- Provides ongoing assistance and support.

Professional development for school improvement:

- Has as its central goal the improvement of student learning.
- Is embedded in the daily life of all teachers.
- Fosters a norm of continuous individual, collegial, and organizational improvement.
- Has been aligned with the school's and the district's strategic plan, and is funded by a line item in the budget.
- Respects and nurtures the intellectual and leadership capacity of teachers, principals, and other in the community.
- Reflects the best available research and practice in teaching, learning, and leadership.
- Fosters a deepening of subject-matter knowledge, a greater understanding of learning, and a greater appreciation of students' needs.
- Provides for three phases of the change process: initiation, implementation, and institutionalization.
- Provides a framework for integrating innovations and relating those innovations to the mission of the organization.
- Helps teachers and other school staff meet the needs of students who learn in different ways and who come from diverse cultural, linguistic, and socioeconomic backgrounds.
- Provides adequate time during the work day for inquiry, reflection, and mentoring.
- Is driven by a coherent long-term plan, and sustains long-term change in practice.
- Involves participants in planning and making decisions designed to improve the school.
- Is site-based.
- Supports a clearly articulated vision for students.
- Uses systemic evaluations to assess its impact on teacher effectiveness and student learning, and uses information form this evaluation to guide subsequent professional development efforts.

(Educational Research Service, 1998, p.3)

GK-12 Program

There has been little published material on GK-12 (Gilmer et al., 2005). A careful examination of the ERIC, Education Full Text, Professional Development Collection, ProQuest Digital Dissertation, and Google Scholar revealed minimal work on the program. The most relevant works found were evaluation reports by Mitchell, Levine, Gonzalez, Bitter, Webb, and White (2003) and Williams (2002); conference papers by Balinsky, Gilmore, and Davis (2006), Brown (2006), Ferreria (2006), Huziak, Van Hook, Nurnberger-Haag, and Ballone-Duran (2006), Thompson and Lyons (2006), and Thompson, Metzgar, Collins, Joeston, and Shepherd (2002a); an article by Thompson, Collins, Metzgar, Joeston, and Shepherd (2002b); and a monograph by the Southeast Eisenhower Regional Consortium for Mathematics and Science Education at Gilmer et al. (2005).

Mitchell et al. (2003) conducted a qualitative analysis of case studies from twelve sites and a quantitative analysis of survey data gathered from all GK-12 sites. The strongest aspects of the programs were: (a) gains in content knowledge for teachers; (b) Fellows were positive role models for students; (c) increased collaboration in school-university relationships; and (d) improvement of communications and instructional skills for Fellows. Less strong aspects of the programs included (a) Fellows' and teachers' roles needed clarification; and (b) summer training did not provide time for relationships to form between teachers and Fellows, and did not prepare Fellows for the classroom.

Williams's study (2002) was conducted through RAND's Science and Technology Policy Institute. The researcher conducted an exploratory case study of eight GK-12 sites. The successful common characteristics of programs included: (a) program

participants held a shared vision; (b) key influential individual(s); (c) resources and time for planning; (d) collaboration and support from social science departments, including education, psychology, and sociology; and (e) partnership schools in proximity to the university. Some issues that required further attention included: (a) the needs of K-12 schools were not met by program designs; (b) lack of proper evaluation; and (c) poor relationships between some school and university members.

Balinsky et al. (2006) interviewed four Fellows and ask each to write a chapter in the Gilmer et al.'s (2005) monograph. Successful aspects included: (a) Fellows negotiated their identities as both scientists and science educators; (b) Fellows developed in pedagogical and communication skills; and (c) Fellows enriched their content knowledge. An issue that required further attention is that Fellows felt a separation of culture which caused a lack of identity (scientist vs. science educator).

Brown (2006) studied 12 Fellows during over the course of a year. Fellows completed pedagogical interviews, efficacy belief instruments, and wrote weekly journal reflections. The successful aspects include: (a) significant change in Fellows' personal teaching efficacies; and (b) Fellow enriched their understanding and perceptions of reform based instructional strategies. Findings also showed that Fellows do not easily change their beliefs of the elementary school classroom and student.

Ferreria (2006) studied Fellows in a large urban district from 2002-2005. The data was obtained through observations, and interviews of Fellows and teachers. The successful aspects of the program for Fellows included gains in: (a) content knowledge; (b) problem solving; (c) working with a diverse population; and (d) communication skills. No explicit shortcomings were described.

Huziak et al. (2006) studied a GK-12 site for one year in 4-6 grade classrooms. Fellows were given a pre/post inquiry survey, pre/post attitude survey, asked to write e-journals, and were observed in their classrooms. Interviews of principals and teacher focus groups were used as well. Successful aspects included collaborations between Fellows and teachers that were beneficial to Fellows, teachers, and students. No explicit shortcomings were described.

Thompson and Lyons (2006) conducted a three year experimental study of a GK-12 site. Students in experimental and control group classrooms were interviewed and asked to draw a picture of an engineer. Results showed that students deepened their understanding of: (a) the engineering process; and (b) the diversity of the engineering field and its attributes. No explicit shortcomings were described.

Thompson et al. (2002a) and Thompson et al. (2002b) conducted a one-year, observation- and interview-intensive, qualitative study of one site. The primary findings from the conference paper were: (a) Fellows' and teachers' collaborations increased content knowledge for teachers; (b) Fellows and teachers formed strong collaborations and interactions; (c) students witnessed scientific interactions in the classroom which helped students understand the social aspect of science; (d) curriculum knowledge increased for teachers; and (e) Fellows reported increases in student learning of the nature of science, and ideas concerning instructional techniques. No explicit weaknesses were reported. The findings from the article were: (a) Fellows enhanced their understanding of science content; (b) Fellows developed a fuller understanding of inquiry based science; (c) Fellows developed a stronger understanding of the complexities of teaching science. Negative outcomes included; (d) time constraints for Fellows; and (e) Fellows felt

strained in determining a focus between teaching secondary science and becoming a research scientist.

Gilmer et al. (2005) studied how Fellows' ideas of effective teaching and understandings of the nature of science have changed or were changing as a result of the program. Findings include: (a) improved teaching to diverse styles of learning and improvements in science content; (b) new understanding of alternative forms of assessment for student knowledge and learning; (c) new understanding of different cognitive abilities, constructivism, and conceptual learning; and (d) movement from positivistic views of the nature of science. The only reported issue that required further attention was further progress in the Fellows' understanding of the nature of science.

Professional Development Evaluation

According to Guskey (2005) the evaluation of professional development is judged on five levels: (a) participants' reactions; (b) participants' learning; (c) organizational support and change; (d) participants' use of new knowledge and skills; and (e) student learning outcomes. The levels are hierarchical and build on each other; therefore, the highest level, student learning, takes the most time and effort to determine. Many professional development evaluations determine the effectiveness of their programs by participants' reactions or participants' learning. Although these levels aid in answering important questions about the programs, they are simple and not always related to improvements in student learning. The further the evaluated levels are from the top level, the lesser the chances the experience will improve student learning.

Summary

Chapter three is a comprehensive review of lists, studies, and books that focus on or describe effective characteristics of professional development. Each work is summarized and its characteristics, when applicable, have been presented verbatim. This chapter also examines work on professional development evaluation, the GK-12 program, and GK-12 program research.

Chapter 3

Methodology

Overview

The purpose of this study was to find ERBCPD, and to use these descriptions to investigate the GK-12 program. The three research question are: (a) What are the effective research-based characteristics of professional development?; (b) What are the effective research-based characteristics of professional development of the GK-12 program?; (c) What are effective research-based characteristics of professional development of the GK-12 program that are not answered by Question One? Why are these characteristics not mentioned?

This study originated as a pilot study where this researcher directly worked with GK-12 Fellows in and outside of the classroom. From this initial work, questions emerged that were of interest to this researcher and the science education community. A mixed-methods approach was used to answer the research questions. The approach was structured on three content analyses (see Table 3.1). First, ERBCPD lists were studied with an emergent content analysis where raters determined categories and formal descriptions. A second content analysis used the formal descriptions to check for reliability. The last content analysis is the GK-12 analysis. This analysis used formal descriptions from the second content analysis for coding. Emergent categories and formal descriptions were also created in the final analysis.

Table 3.1: Three Content Analyses

Content analysis	Unit of analysis	Purpose	Coding	Validity	Reliability
1	ERBCPD lists	Determine ERBCPD	Emergent	N/A	intra-rater
2	ERBCPD lists	Inter-rater reliability for first content analysis	*A priori*	interview of experts	intra-rater
3	GK-12 evaluations (findings sections)	Determine ERBCPD for GK-12 and emergent ERBCPD for GK-12	*A priori* and emergent	Emergent ERBCPD compared to literature	intra-rater and inter-rater

When the final descriptions of the ERBCPD were determined, they were shared with experts in professional development research. The experts were interviewed, and their comments led to further study. When the emergent formal descriptions of ERBCPD for GK-12 were completed, they were compared to the present GK-12 literature.

Pilot Study

In 2004-2005, a large south central Research I university placed three science doctoral students into 7-12 grade classrooms as part of GK-12. The Fellows were partnered with practicing teachers to teach science lessons. In order to familiarize himself with GK-12, this researcher conducted weekly observations of the three Fellows in the classroom and attended periodic meeting (see Appendix A for IRB). As observations were made, research questions that the science education community would believe to be of value, emerged. Ultimately, the pilot study examined three GK-12 Fellows' teaching beliefs, content knowledge, pedagogical knowledge, and nature of science understanding in the midst of the one year program. The results of the study showed that Fellows have a deep understanding of content knowledge, slightly informed

views of the nature of science, and slightly teacher-centered beliefs and pedagogical knowledge. The discussion section outlines recommendations for how to change teaching beliefs and pedagogical knowledge of Fellows.

Methodology

This study was conducted through a constructivist framework in order to answer the research questions. Constructivism was used because this researcher believed a relativistic and pluralistic view of reality (Guba & Lincoln, 1994) would best address the research question, and that the study's data and analysis is believed to be variable and transformable depending on one's perspective. The methods are qualitative, and four instruments were administered to two Biological Sciences and one Geological Sciences Fellows. The nature of science and content knowledge instruments were administered as written response worksheets, and the beliefs and pedagogical knowledge instruments were presented as interviews. The interviews were semi-structured and open ended (Merriam, 1988), and based on a few questions, although the interviewer probed the Fellows for richer and more detailed answers when necessary. As the data was collected from the Fellows, findings were transcribed, aggregated and compared (Merriam, 1998).

Beliefs

Each Fellow was interviewed using Interview Maps (Luft, Roehrig, Brooks, & Austin, 2003) (see Appendix B) to determine ideas of science teaching beliefs. The first five questions (see Appendix B) probed beliefs that were rated traditional, instructive,

transitional, responsive, and reform-based. The categories for the last question (see Appendix B) were based on models of science teaching, and were scored as product, procedural, process, inquiry, and relevance. The responses represent student-centered to teacher-centered beliefs of teaching. Two researchers independently rated the three Fellows' written responses. After both researchers finished, they compared their ratings, and discussed any disagreements. Disagreements were discussed, issues regarding disagreements were addressed, and ratings were made. If agreements were not reached, the aspect's rating was discarded.

Pedagogical Knowledge

A pedagogical knowledge instrument (Puthoff, 2005) (see Appendix C) was administered to the Fellows. Each question presents a scenario and Fellows' responses were rated as minimal/absent, preliminary, emerging, or proficient. The responses represent student-centered to teacher-centered pedagogical knowledge. Two researchers independently rated the three Fellows' written responses using the same process used for the beliefs instrument.

Content Knowledge

Recognized assessments were used to assess the content knowledge of the Fellows. The two biology Fellows took the Preliminary Bioliteracy Questionnaire (see Appendix D), which was created by the Bioliteracy Project in Boulder, CO. The geology Fellow was asked to draw a concept map of the discipline since no appropriate content instrumentation exists for geology. The Preliminary Bioliteracy Questionnaire was then

scored, and the concept map was evaluated by this researcher and a geological sciences graduate student.

Nature of Science

Two researchers independently rated the three Fellows' written responses to the Views on the Nature of Science – version C (VNOS-C) (Abd-El-Khalick, Bell, & Lederman, 1998) (see Appendix E). Each aspect of the nature of science was rated either "more naïve view" or "more informed view" (Abd-El-Khalick et al., 1998). Two researchers independently rated the three Fellows' written responses using the same process used for the beliefs instrument.

Findings

Findings for the study are found on Tables 3.2 to 3.5. This section is composed of four parts: beliefs (Table 3.2), pedagogical knowledge (Table 3.3), content knowledge (Table 3.4), and nature of science (Table 3.4). The beliefs section is arranged into two groups: one reports conventional beliefs and the second section reports question 6, which investigates models of science teaching. The numbers in both belief sections and the pedagogical knowledge section denote the question number. For example, Devon's pedagogical knowledge rating for question number 2 is *preliminary*. Finally, the nature of science findings list every question asked, and how the Fellow was rated.

Table 3.2: Belief Results

Beliefs	Traditional	Instructive	Transitional	Responsive	Reform-based
Devon (pseudonym)		1,2,3,5	4		
Casey (pseudonym)	1	5	2,3,4		
Bailey (pseudonym)	1,2	3	4,5		
Beliefs (models of science teaching)	Product	Procedural	Process	Inquiry	Relevance
Devon			6		
Casey		6			
Bailey		6			

Table 3.3: Pedagogical Knowledge Results

Pedagogical Knowledge	Minimal/Absent	Preliminary	Emerging	Proficient
Devon		1,2	3	
Casey		1,2	3	
Bailey		1,2	3	

Table 3.4: Content Knowledge Results

Content Knowledge	Score
Devon	Perfect score
Casey	Perfect score
Bailey (Concept Map)	Deep understanding

Table 3.5: Nature of Science Results

Nature of science	More naïve views	More informed views
1. Empirical NOS	Casey, Devon	Bailey
2. The Scientific Method	Devon	
3. General structure and aim of experiments		Bailey, Devon
4. Role of prior expectations in experiments		
5. Validity of observationally-based theories and disciplines	Devon	Bailey, Casey
6. Scientific theories		
Nature of		Bailey, Casey, Devon
Functions of		Bailey, Casey, Devon

Logic of testing		Bailey, Casey
7. Difference and relationship between theories and laws	Bailey, Casey, Devon	
8. Tentative NOS	Casey, Devon	Bailey
9. Creative and imaginative NOS		Bailey, Casey, Devon
10. Inference and theoretical entities		Bailey, Casey, Devon
11. Subjective or theory-laden NOS		Bailey, Casey
12. Social and cultural embeddedness of Science	Devon	Bailey, Casey

Discussion

The results of the study show that Fellows have a deep understanding of content knowledge, closer to more informed views than more naïve views of the nature science, and slightly teacher-centered beliefs and pedagogical knowledge. Based on these results, the PI of the program may address the Fellows' needs and create activities that will better prepare them to teach in a more reform-based fashion. The areas that need the most attention are teaching beliefs and pedagogical knowledge. For teaching beliefs, the Fellows would benefit from researched and effective activities that address how students learn, cognitively-appropriate instruction, and diverse styles of learning. For pedagogical knowledge, Fellows would benefit from researched and effective instruction on how to maximize student interactions, multiple forms of assessment, and student involvement.

Rationale

A mixed-methods approach was selected to answer the research questions. This method is most appropriate because the combination of qualitative and quantitative aspects will yield a stronger analysis than a single approach. For example, content

analysis, which is generally a quantitative approach, was used as the primary method to analyze data. It was best to use an inductive mean to delineate the characteristics because the current understanding of the ERBCPD is nebulous as recognized in the literature review. Once a hypothesis of ERBCPD is formed, then a quantitative analysis was used to either support or refute the findings via present/absent coding. Other quantitative aspects included periodic checks for reliability. Lastly, the ERBCPD was investigated once again qualitatively, this time by interviews of experts in professional development research.

Content Analysis

Content analysis is a systematic and quantitative empirical method that describes the content of text (Berelson, 1952) by identification of terms, phrases, or other characteristics (Holsti, 1969), and creates categories that are mutually exclusive and complete (Herkner, 1974). Krippendorff (2004) defines the method as a technique for making replicate and valid inferences from data. Holsti (1969) defines it as a method for creating inferences by objectively identifying specified information. Content analysis is based on the assumption that language can convey an importance of priority, understanding, and meaning of individual, group, institutional, and social attention (Weber, 1990). The method is most often used in mass communication research, but is common in education and to study aspects of the sciences as well. Examples of past uses of content analysis include studies in scientists' ideologies and how they defend their

ideologies (Gieryn, 1983), investigations in school mission statements (Stemler & Bebell, 1998), and themes in children's drawings (Haney, 1998).

Effective Research- Based Characteristics of Professional Development Content Analysis

Nineteen lists describing ERBCPD were found using ERIC, Education Full Text, Professional Development Collection, ProQuest Digital Dissertation, and Google Scholar. These 19 lists are a comprehensive body of existing texts published and/or written between 1995 and 2005. Many other lists were found, but most were published by the same authors and/or research groups. For example, Birman, et al. (2000), Porter et al. (2000), and Garet et al. (2001) are texts written by the same research group that have published much work on professional development. Only the Garet et al.'s (2001) list was used because it summed up most of the work of the other papers and was the most recent. The next step was to remove lists that were not research-based and/or not related to student learning and teacher behavior. Lists that were based on a research synthesis had to have at least one study that was research-based to be included in the analysis. Lists must have also provided at least one component of student learning and/or teacher behavior evaluation. Two lists were removed and included ASCD (2002), and CPA (2005); both of which contained no references or evaluations of student learning and/or teacher behavior.

The units of analysis for the first and second content analyses were the remaining 17 ERBCPD lists. The first step was to conceptually identify the categories that

compromised the descriptions of ERBCPD. This was accomplished with an emergent coding analysis which created the new categories to be coded. This researcher enlisted two raters and trained them on the coding process (training procedures are described in the "reliability" section). The raters then read the ERBCPD lists and took notes on themes that they noticed. These themes became categories on an individual checklist. The raters then looked over both checklists, compared and condensed the two, and created a draft-coding sheet (Haney, 1998). Next, the raters independently read over all the lists once again, and recorded the absence or presence of each category on the draft-coding sheet. The raters also took note of categories that did not appear on the draft-coding sheet but should have been considered. The two raters reconvened to compare and contrast their results. Items with highest levels of agreement ($K \geq 70\%$) were formally described and noted as possible ERBCPD (Haney, 1998). Those with lower levels of agreement ($K < 70\%$) were discussed, issues were addressed, and categories were formally defined. When agreements were not found, the features were struck through with a line. The next day an intra-rater reliability check was performed to ensure *stability*, or the tendency for raters to consistently code data in a similar fashion.

When the formal descriptions were completed, two new raters were trained on the coding process. The raters were asked to read over the formal descriptions on a new draft-coding sheet. Next, the raters independently looked over all ERBCPD lists and recorded the occurrences of categories on the sheet. The next day, an intra-rater reliability check was performed to ensure stability (see upcoming section for reliability definitions). Afterwards, the researcher compared the coding from both pairs of raters and struck trough any categories that showed low agreement levels ($K < 81\%$). The final

formal descriptions composed the ERBCPD. The next day an intra-rater reliability check was performed to ensure stability.

GK-12 Program Content Analysis

In 1999, 31 institution of higher education participated in the GK-12 program. The GK-12 program director, Dr. Sonia Ortega, was contacted by this researcher and informed her of the specifics of the study. Dr. Ortega sent this researcher an Excel sheet that listed the 31 institutions that participated in the GK-12 starting in 1999 and had completed and sent their final evaluations to NSF. The Excel sheet also included the names of the PIs and their school addresses. In June 2005, 31 letters were sent to the institutions (see Appendix F). After a minimal response, a second letter was sent out to nearly every institution in August 2005. In December 2005, every site PI that did not respond to the first two letters was sent an email (see Appendix G). One last, more personalized email was sent to the PIs in February of 2006. In March 2006, this researcher began calling PIs and asked them for their evaluations. By April 2006, 26 of the 31 PIs had either emailed their evaluations to this researcher, or told him that he had permission to request the intuition's evaluations from NSF. All evaluations sent from NSF to this researcher were by NSF's Albert Einstein Fellow, Daniel Carpenter. Mr. Carpenter emailed this researcher the final evaluations and carbon copied the emails to the PIs.

The units of analysis for the GK-12 content analysis were the *Findings* sections of the GK-12 evaluations. Most GK-12 evaluations are standardized and the *Findings*

section is located between the *Research and Education Activities* and *Training and Development* sections. If the standardized findings section makes a direct reference to a particular section, graph, table, or figure found somewhere else in the evaluation, the referenced item was also included. Any evaluations that were not standardized were used only if a discrete findings section appeared. Discrete was defined as a section that is titled *Findings*. Twenty-one of the 26 evaluations had a *Findings* section; the other four evaluations were discarded

The GK-12 analysis consisted of an *a prior* and emergent content analysis. The analysis used the formal descriptions from the ERBCPD content analysis, and raters were asked to identify emergent themes that did not appear on the coding sheet. The researcher enlisted two new raters and trained them on the coding process. The raters independently look over all units and recorded the presence or absence of the category on Draft-coding Sheet A. The raters then re-read the samples and took notes on emergent themes. These emergent themes become Draft-coding Sheet B. The raters then looked over both Draft-coding Sheets A and B, compared and condensed the two, and created Draft-coding Sheet C (Haney, 1998). An inter-reliability check was performed on Draft-coding Sheet C. *A prior* categories with highest levels of agreement ($K \geq 81\%$) were noted as ERBCPD for GK-12 (Haney, 1998). Those with lower levels of agreement were discussed, and issues addressed. If agreements were not made, then the categories were struck through with a line. Emergent categories with the highest levels of agreement ($K \geq 70\%$) were formally described and noted as a possible ERBCPD for GK-12 (Haney, 1998). Those with lower levels of agreement were discussed, issues addressed, and categories formally defined. If agreements were not evident, the categories were struck

through with a line. The lists had to show an indicate agreement level of at least 81% for *a priori* coding and 70% for emergent coding. If any of the categories had agreement levels below this percentage, the GK-12 analysis will be repeated. This process continued until overall agreement levels are at least 81% for *a priori* coding and at least 70% for emergent coding.

Emergent Characteristics of GK-12 Program

The emergent ERBCPD of GK-12 from the third content analysis were compared to Thompson et al. (2002a), Thompson et al. (2002b), Williams (2002), Mitchell et al. (2003), Balinsky et al. (2006), Brown (2006), Ferreria (2006), Huziak et al. (2006), Thompson and Lyons (2006), Gilmer et al. (2005) and the GK-12 program solicitation (NSF, 2005). When the characteristics aligned, a descriptive portrait of the similarities was written. When the characteristics differed, a literature review of the specific characteristics was conducted, and explanations of the differences were addressed.

Reliability

Since content analysis is replicable, reliability is important. It is important for raters to have appropriate backgrounds and qualifications that are shared by a large population of potential raters (Krippendorff, 2004). Peter and Lauf (2002) recommend that raters have the same cultural, educational, and professional background. All the raters used for these content analyses were American-born, science and mathematics

education graduate students with past teaching experience, and no experience in designing or implementing professional development for K-12 teachers.

Training is an important aspect to reliability, and many content analysts spend months training raters in order to refine categories and create reliable coding sheets (Krippendorff, 2004). The training session for the ERBCPD content analyses began with this researcher explaining to the raters the goal of the task: to reduce the ERBCPD from 17 lists using a method called content analysis. Emergent content analysis raters were presented with four child-like drawings depicting houses, cars, trees, and other objects. Raters were asked to look at the drawings and individually take notes on themes that they notice. The raters looked over both lists, compared and condensed the two, and created a draft-coding sheet which included houses, cars, and trees. Next, the raters independently looked over all the drawings once again, and recorded the absence or presence of each category on the draft-coding sheet. *A priori* ERBCPD content analysis raters were presented with four drawings depicting houses, cars, and trees. Raters were then given a draft-coding sheet, asked to independently look over all the lists, and recorded the presence or absence of each category on the draft-coding sheet.

The training session for the GK-12 content analysis began with this researcher explaining to two new raters the goal of the task: to investigate GK-12 evaluations using the method of content analysis. Raters were presented with four child-like drawings depicting houses, cars, trees, and other objects. Raters were asked to look at the drawings and individually use a draft-coding sheet to depict the themes as either "present" or "absent". After the raters looked over the drawings, they were asked to take notes on themes that they noticed, but were not on the draft-coding sheet. For example, "house",

"car", and "tree" were all found on the draft-coding sheet, but three of the four drawing also had flowers. Raters reconvened and discussed the emergent "flower" and other emergent characteristics. The raters then read the emergent characteristics, compared and condensed the two, and created a draft-coding sheet which included houses, cars, trees, and flowers. Next, the raters independently looked over all the drawings once again, and recorded the occurrence of the new category on the draft-coding sheet.

The two types of content analysis reliability are intra-rater and inter-rater. Inter-rater reliability measures how often different raters code the same list with the same results. Differences are usually due to raters' poor understanding of categories or coding rules. Intra-rater reliability measures how often the same rater chooses the same code for the same list, try after try. Low scores in intra-rater reliability are usually due to poor understanding of categories, coding rules, cognitive changes within coder and simple bookkeeping error (Weber, 1990).

The best method for increasing inter-rater reliability is to test raters' counts with Cohen's kappa (K). This was done after the coding was completed and before the raters' discussions. This researcher recorded the number of agreed-upon cases and the total number of cases. Then the numbers were inputted into the following formula:

$$K = (P_{agreed} - P_{chance})/(1 - P_{chance})$$

P_{agreed} is the percent of cases agreed upon
P_{chance} is the percent of cases agreed upon by chance alone

Landis and Koch (1977) recommend that $K \geq 81\%$ for inter-rater reliability, but for exploratory studies such as the emergent content analysis, Lombard, Snyder-Duch,

and Bracken (2002) state that K $\geq$ 70% is acceptable. For the a priori content analyses, if K < 70%, the raters discussed their ideas, reread the categories and formal descriptions, and recoded the list. This process continued until K $\geq$81% was reached. Intra-rater reliability tests were conducted the day after the initial content analysis and K $\geq$ 81% was reached.

Validity

The validity of a study increases as different methods are used to investigate the same construct. Often the term *triangulation* is used to describe this endeavor. Two steps were used to triangulate the data. The first was to send the ERBCPD and a description of the study to three experts in the field of professional development research, and request their participation in a short phone interview (their expertise will be described in the next section). The interviews were open-ended (Merriam, 1988), with this researcher probing the experts for more-detailed answers. The last two questions were not always necessary based on the response to the first question.

The questions asked were as follows:

1. You have looked over the list of effective characteristics of professional development. Do you agree or disagree with this list, and why?
2. Do you see any characteristics that should or should not be on the list?
3. Do you have any additional comments pertaining to the list or the study?

The phone interviews were transcribed into written text, and used to both support and refute characteristics. Characteristics that were refuted or omitted were specifically investigated in a post hoc literature review. The validity portion of the GK-12 content analysis will also be a post hoc literature review since very little research has been conducted on GK-12.

Experts

Three experts of professional development were interviewed for the qualitative portion of study (see Appendix H). The reputation of the experts and their background is important because it will increase this study's substantive significance. The content from the following short biographies have been taken from each expert's website. The biographies were then sent to the experts for corrections or additional information.

Dr. Thomas Guskey is a professor of education at the University of Kentucky. He received his Ph.D. in Measurement, Evaluation, and Statistical Analysis from the University of Chicago. He has served as Director of Research and Development for the Chicago Public Schools, and the Director of the Center for the Improvement of Teaching and Learning. Dr. Guskey is on the Editorial Board of *Journal of Research on Professional Learning*, The Elementary School Journal, and Educational Measurement: Theory and Practice. He has also served on the Policy Research Team of the National Commission on Teaching & America's Future, and the committee that developed the National Standards for Staff Development. He has authored and edited over 100 journal articles and 12 books, including the professional development standard, *Evaluating*

Professional Development (2000).

http://www.uky.edu/Education/EPE/epefac.html#Guskey

Judith Mumme directs components of numerous mathematics professional development and research projects at WestEd. She is the PI of Researching Mathematics Leader Learning, a project designed to research how leaders cultivate mathematically rich environments in professional development. She is also PI of the Leadership Curriculum for Mathematics Professional Development; a project that creates curriculum materials to support the development of educational leaders of mathematics professional development. She is PI of Developing Facilitators of Practice-Based Professional Development; a program that prepares educational leaders in the facilitation of practice-based professional development. Ms. Mumme has also served as co-PI/Director of the California State Systemic Initiative, the Mathematics Renaissance K-12, and California Alliance for Mathematics and Science.

http://www.wested.org/cs/we/view/u/167

Dr. Carol Fletcher is program manager of the Texas Regional Collaboratives for Excellence in Science Teaching (TRC). The TRC is a statewide network of K-16 partnerships that provide researched-based professional development to K-12 teachers of science across Texas. The TRC is composed of 37 institutions of higher education that collaborate with the Texas Education Agency, school districts, education service centers, and business partners. The program, now in its 14th year, aids in the designing and implementing of exemplary science professional development.

http://ci06.edb.utexas.edu/trc/about_us.html

Summary

A mixed-methods approach was taken to answer the research questions. The approach was structured on three content analyses, each with a different purpose. The products of the analyses were categories and formal descriptions for ERBCPD, ERBCPD of GK-12, and emergent ERBCPD of GK-12. Tests for intra-rater and inter-rater reliability were performed and had to meet specific criteria. Validity was addressed with expert interviews and a post hoc literature review.

Chapter 4

Findings

Introduction

This chapter describes the findings from the study and answers the three research questions: (a) What are the effective research-based characteristics of professional development related to student learning and teacher behavior? (Table 4.19); (b) What are the effective research-based characteristics of professional development of the GK-12 program, related to student learning and teacher behavior? (Table 4.34); and (c) What are effective research-based characteristics of professional development of the GK-12 program that are not answered by Question One? Why are these characteristics not mentioned? (p. 80). The contents of this chapter and Appendix I include ERBCPD coding sheet results, GK-12 coding sheet results, intra- and inter-rater reliability coding sheet results, interview results, post hoc emergent characteristics validity results, summative content analyses results, and GK-12 student achievement results. This chapter also includes results for the failed GK-12 content analysis which had to be repeated.

ERBCPD Content Analysis Findings

ERBCPD Content Analysis One

Tables 4.2 and 4.3 show the draft coding sheets for Raters 1 and 2 (See Appendix I for Tables 4.2-4-8, 4.10-4.17, 4.22-4.24, and 4.26-4.32). The numbers at the top of the columns correspond with the lists numbered on Table 1.1. All of the categories were

derived from the emergent portion of the first content analysis. After the raters created the categories, they labeled each cell in the coding sheets with an "A", which represents "absent" or "P" which represents "present" (see Table 4.1). When the raters completed coding, they discussed their differences. If differences were agreed upon, the changes were recorded on Table 4.8. If the differences could not be agreed upon, the letter "N" appears in the appropriate cell on Table 4.8. The results of the first content analysis are found in Table 4.9. The last two columns in the table list inter-rater reliability scores before and after the discussion. The only characteristics that had a K<70% was *d: Design is based on research* and is stuck trough.

Within 36 hours of the first content analysis, raters were asked once again to code in order to check for intra-rater reliability. The asterisk represents a discrepancy between the scoring of the rater's first draft coding sheet and second. For example, Tables 4.2 is the first draft coding sheet for Rater 1, Table 4.4 is the results from the intra-reliability coding sheet for Rater 1, and Table 4.5 shows the differences between Table 4.2 and Table 4.4. All intra-rater reliably scores were K>81%.

Table 4.1 Symbols Key for Tables 4.2 to 4.34

A	characteristic is absent	K	Cohen's Kappa value
P	characteristic is present	~~word~~	characteristic's Kappa was too low
N	characteristic was not agreed upon	+	GK-12 emergent characteristic
*	inter-rater reliability differences		

Table 4.9: ERBCPD Draft-Coding Sheet Results and Formal Descriptions, Raters 1 and 2

	Characteristics	K before discussion	K after discussion
a	Teachers' discipline-specific knowledge is increased	0.72	0.72
b	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.	0.75	0.74
c	Teachers understand how students learn and what are effective teaching strategies.	0.46	1
d	~~Design is based on research~~	0.55	~~0.66~~
e	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.	0.88	0.88
f	Requires resources (money and time)	0.28	1
g	Professional development is on-going	0.77	0.77
h	Professional development occurs in day-to-day contexts of teachers	1	1
i	Uses effective teaching strategies	0.26	1
j	Coherent/aligned with school/district/state goals	0.48	0.77
k	Teachers provide input into professional development design; professional development is engaging and relevant	0.35	0.85
l	Involves collaboration between teachers and others	0.72	0.72
m	Generates further collaboration or projects	0.49	0.74
n	Treats teachers as professionals	0.23	0.88
o	Promotes teacher self-reflection	0.35	1
p	Uses inquiry as a teaching style	0.25	0.85
q	Increases teacher ability to meet needs of diverse learners	1	1

ERBCPD Content Analysis Two

The purpose of content analysis 2 was to check for reliability, and two new raters were asked to code. The numbers at the top of the columns (see Tables 4.11 to 4.16 correspond with the lists numbered on Table 1.1. Tables 4.10 and 4.11 are the draft coding sheets for Raters 3 and 4, respectively. The raters looked through the ERBCPD lists and labeled each cell as "A" or "P". When the raters finished, they labeled and discussed their discrepancies (see Table 4.16). Both raters agreed on every instance, and therefore every K=1. The results of the second content analysis are found on Table 4.17. The last two columns in the table list inter-rater reliability scores before and after the discussion. Table 4.18 reports on both ERBCPD content analyses and lists all inter-reliability results, and Table 4.19 is the list of the final ERBCPD.

Within 36 hours of the second content analysis, raters were asked to code in order to check for intra-rater reliability. For example, Tables 4.10 is the draft coding sheet for Rater 3, Table 4.12 is the reliability coding sheet for Rater 3, and Table 4.13 shows the discrepancies between Table 4.10 and Table 4.12. All intra-rater reliability scores were K>81% for both raters.

Table 4.18: ERBCPD Reliability Results of Content Analysis 1 and 2

	Characteristics	CA 1 K before discussion	CA 1 K after discussion	CA 2 K before discussion	CA 2 K after discussion
a	Teachers' discipline-specific knowledge is increased	0.72	0.72	0.77	1
b	Teachers understand how students learn and what are effective teaching strategies within a specific discipline	0.75	0.74	1	1
c	Teachers understand how students learn and what are effective teaching strategies	0.46	1	0.49	1
d	~~Design is based on research~~	0.55	~~0.66~~	x	x
e	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked	0.88	.88	0.88	0.88
f	Requires resources (money and time)	0.28	1	0.72	1
g	Professional development is on-going	0.77	0.77	0.64	1
h	Professional development occurs in day-to-day contexts of teachers	1	1	0.52	1
i	Uses effective teaching strategies	0.26	1	-0.02	1
j	Coherent/aligned with school/district/state goals	0.48	0.77	0.55	1
k	Teachers provide input into professional development design; professional development is engaging and relevant	0.35	0.85	-0.08	1
l	Involves collaboration between teachers and others	0.72	0.72	0.55	1
m	Generates further collaboration or projects	0.49	0.74	0.16	1
n	Treats teachers as professionals	0.23	0.88	0.04	1
o	Promotes teacher self-reflection	0.35	1	0.27	1
p	Uses inquiry as a teaching style	0.25	0.85	0.63	1
q	Increases teacher ability to meet needs of diverse learners	1	1	1	1

Table 4.19: Final Effective Research-Based Characteristics of Professional Development

1. Teachers' discipline-specific knowledge is increased
2. Teachers understand how students learn and what are effective teaching strategies within a specific discipline
3. Teachers understand how students learn and what are effective teaching strategies
4. Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked
5. Requires resources (money and time)
6. Professional development is on-going
7. Professional development occurs in day-to-day contexts of teachers
8. Uses effective teaching strategies
9. Coherent/aligned with school/district/state goals
10. Teachers provide input into professional development design; professional development is engaging and relevant
11. Involves collaboration between teachers and others
12. Generates further collaboration or projects
13. Treats teachers as professionals
14. Promotes teacher self-reflection
15. Uses inquiry as a teaching style
16. Increases teacher ability to meet needs of diverse learners

ERBCPD Validity Interviews

Table 4.19 was sent to three professional development experts who were asked to participate in a phone interview to comment on the findings. After the experts were interviewed, transcriptions were written, line-by-line coding was conducted, and a focus coding table (see Table 4.20) was created. After this researcher looked over the line-by-line, and focused coding, memos (see Table 4.21) were written to study and understand the experts' ideas. The memos became the rough drafts for the qualitative validity portion of the study. All of the themes stated by the experts resurfaced and were expanded upon in the discussion chapter.

Table 4.20: Focused Coding

1) Questioning the difference between numbers 2 and 3 2) Questioning the amount and type of input teacher should have in professional development (number 10) 3) Defining effectiveness 4) Stating the difficulty in studying complex situations and questioning the notion of a list and over-simplifying phenomena

Table 4.21: Memos

1) Questioning the difference between numbers 2 and 3 Two of the experts commented on the differences between characteristic number 2 and 3 on the list. The two characteristics are the same with the expectation of number 2 which ends with the segment, "…within a specific discipline". I assume that the difference between the two is that number 2 describes pedagogical content knowledge (PCK) and 3 describe pedagogical knowledge (PK). This makes sense since characteristics number 1 address content knowledge (CK). These three characteristics align with Shulman's work. After discussing the two characteristic, both experts agreed that 2 and 3 are addressing PCK and PK, respectively. Two of the experts believed that these characteristics could

be worded in a finer manner. One expert comment that since this researcher is not just publishing a list of characteristics, he should write short descriptions for each characteristic.

One concern that this researcher has with the difference between 2 and 3 is that since science and mathematics education graduate student worded the characteristics, they may have a greater theoretical understanding of these ideas versus an in-service teacher. This may be problematic because a purpose of this study is to create a practical list of effective characteristic for educational leaders. Therefore, the descriptions that accompany the characteristics must be clearly understood by those who design and implement professional development.

2) Questioning the amount and type of input teacher should have in professional development (number 10)

Two of the three experts are concerned with number 10. Both believe that one should be careful when giving teachers too much power. Both experts mentioned that teacher sometimes do know what they need, and often take a symptomatic approach to their needs. For example, Expert B stated that teacher may notice the symptom; for example classroom management as a problem. The obvious treatment may not be professional development in classroom management, but poorly planned lessons that do not engage students. Expert A makes a similar case, and explains that teacher may express needs that won't help them more towards the goal of a professional development endeavor.

3) Defining effectiveness

Two experts questioned what one means when using the term "effective" to describe characteristics of professional development. Since professional development has many purposes, the idea of effectiveness is often malleable. In this study "effectiveness" is described as professional development that has the potential, based on research-based evidence and measurement, of improving student learning or teacher behavior.

The two issues that the experts had were that professional development is not only about student learning, but may have other goals. Another concern was how effectiveness is evaluated.

4) Stating the difficulty in studying complex situations/questioning the notion of a list and over-simplifying phenomena

The social world is a complex and nebulous place if one wishes to study it from a post-positivistic perceptive using an experimental design. It is impossible to isolate all factors with the exception of the independent variable that one is studying, and directly connect it to a causal relationship with the dependent variable. Two expert stated, not one the characteristic on the list has ever been truly been isolated, tested, and tied to improving student learning or teacher behavior.

Anytime one tell a story, describes the motion of a falling body with mathematics, or publishes a list, reality has been reduced in order to easily communicate information. We

must ask the question at what point does a list, equation, or story loses its context to the point that it no longer can fully communicate what was intended to be communicated. In the case of this study, the question is; will the final list be overly-reduced?

All three experts questioned reducing complex social situation in order to write a list that is has effective intentions. One expert states that many want a formulaic checklist, that could be checked off whenever the professional development leader sees fit. Another expert commented

1) Questioning the difference between numbers 2 and 3

Two of the experts were concerned with the difference between ERBCPD number 2 and 3. The two characteristics use the same wording with the expectation of number 2 which ends with the segment, "…within a specific discipline". Both experts assumed that this difference was in reference to Shulman's work on PK and PCK. This interpretation is strengthened by one expert who states that this makes sense since "…you have CK (as) number one". Both of the experts believed that these characteristics should be worded in a finer manner. One of the experts stated that "[y]ou're going to have to [explain] what…this mean in practice… 2 and 3 are fairly similar and will need to have some distinction between them…either that or they're basically the same". Shulman (1986, 1988) first introduced the term "pedagogical content knowledge" to the field of education. The author states that educators need a deep understand of both content and pedagogical knowledge, and should be able to bring these two knowledges together in order to make ideas accessible to students (Shulman, 1988).

2) Questioning the amount and type of input teacher should have in professional development (number 10)

Two of the three experts showed concerned with ERBCPD number 10. Both believe that one should be careful when giving teachers too much power. Both experts mentioned that teacher sometimes do know what they need, and often take a symptomatic approach to their needs. For example, one expert states that teachers, "… (are) not very good at identifying what they truly need. [They are very good at identifying] problems and concerns as symptoms… [b]ut what happen(s) when you design professional development based by that alone, you deal with the symptomatic issues…not the deep(er) issue(s)". The other expert states that ERBCPD number 10 is "…kind of a mushy one. The expert explains that "…teachers provid(ing) input…(is)…not sufficient, because I often will hear the "make it and take it" perspective in that regard. Just give me a bunch of neat activities to do, and that…(are)…engaging and, (this) in their minds (is) relevant". The same expert states that "…most… [educational leaders of] professional development are tight-roped; walk(ing) between having a sense of what might move a group forward and what they think they need." The expert ends with stating that …[educational leaders] needs to be respectful of teachers…[without letting them have too much control in the direction of professional development].

3) Defining effectiveness

Two experts questioned the term "effective or effectiveness" to describe characteristics of professional development. Both experts were informed how effectiveness was addressed in this study, yet both had issue with the definition and the study as a whole (In this study "effectiveness" is described as professional development that has the potential, based on research-based evidence and measurement, of improving

student learning or teacher behavior). One expert stated that professional development has many purposes. The experts stated "…I definitely agree that [professional development is] about improving student learning but sometimes it is about professional community; there is a profession here." The other expert showed concern for how effectiveness was being evaluated. This expert stated that "One says effectiveness is defined by the opinion of experts; and that (is) where we get a lot of lists. The other [says it] is…based on the feedback we get from educators." The expert explained that we must decide on a definition of effectiveness. The experts also states that many studies have not been linked to teacher practice and student learning. One expert stated "I know that there are efforts that have [linked professional development to improvements in teacher practice and student learning]. Mary Kennedy's work was a good initial exploration and the work…in California by the RAND Corporation would be another…"

4) Questioning the notion of a list and over-simplifying phenomena

All the experts questioned the notion of the list and the oversimplification of complex environments. One expert said "I am not crazy about lists. I think [a list] tries to narrow a very complex field….. I mean if someone can check off each of those things [then] they are done." Another expert said "… I image your research is not just publishing a list. You're going to have to do some explanation of what…this means in practice". Oversimplification, the philosophical extreme know as the reductive fallacy (Abel, 1997), has always been an issue in the sciences, literature, history, and media. Einstein (1993) stated, "The supreme goal of all theory is to make the irreducible basic elements as simple and as few as possible without having to surrender the adequate

representation of a single datum of experience." This statement is usually paraphrased as everything should be made as simple as possible, but no simpler. The reductive fallacy becomes a problem when studying educational settings. Two of the experts stated that not one characteristic on the list has ever been truly been isolated, tested, and tied to improving student learning or teacher behavior. One of the experts stated, "It comes from a design perspective; it is very challenging because there are so many things going on in school at one time. (I)f you would move to the notion of randomized experiment, there is nothing that can guarantee that this is the only treatment going on at that time. And so there are multiple innovations, multiple orientations in a school at any particular time. So to actually pull out and isolate the effects of specific professional development endeavor is very challenging."

Failed GK-12 Program Content Analysis

Two new raters participated in this analysis and both studied the findings sections of 21 GK-12 evaluations. Tables 4.22 and 4.23 are the draft coding sheets for Raters 5 and 6, respectively. The letters at the top of the columns (see Tables 4.22 to 4.24) each correspond to a GK-12 site. The raters labeled either an "A" or "P" on their coding sheets, and when they finished, they labeled and discussed their difference (see Table 4.25). This analysis indicated many disagreements. Since the total number of disagreements was K<81%, the analysis failed and had to be conducted once again. Differences could probably be attributed to the raters' poor understanding of categories and the large amount of data that had to be studied. The results of the failed GK-12

content analysis are found in Table 4.26. The last two columns in the table list inter-rater reliability scores before and after the discussion.

Table 4.25: GK-12 Draft-Coding Sheet Results, Raters 3 and 4 (Failed)

	Characteristics	K before discussion	K after discussion
1	Teachers' discipline-specific knowledge is increased	0.61	0.80
2	Teachers understand how students learn and what are effective teaching strategies within a specific discipline	0	0.41
3	Teachers understand how students learn and what are effective teaching strategies	0	1
4	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked	0.29	0.29
5	Requires resources (money and time)	0	0
6	Professional development is on-going	0.20	0.516
7	Professional development occurs in day-to-day contexts of teachers	0.34	1
8	Uses effective teaching strategies	0.32	0.79
9	Coherent/aligned with school/district/state goals	0.61	1
10	Teachers provide input into professional development design; professional development is engaging and relevant	0.54	1
11	Involves collaboration between teachers and others	0.35	1
12	Generates further collaboration or projects	-0.01	0.81
13	Treats teachers as professionals	0.52	0.90
14	Promotes teacher self-reflection	0	0.64
15	Uses inquiry as a teaching style	0.40	1
16	Increases teacher ability to meet needs of diverse learners	-0.22	0.22
17	Has real world application+	0.77	0.77
18	Improves communication skills+	0.71	0.81

+ represents an emergent characteristic

GK-12 Program Content Analysis Findings

Raters 5 and 6 were asked to repeat the GK-12 content analysis. Coders were reminded of coding rules, and had a much stronger understanding of categories and content since they were repeating the same process from the failed analysis. Once again both raters read the findings sections of the 21 GK-12 evaluations and told the letters at the top of the columns (see Tables 4.26 to 4.32) each correspond to a GK-12 evaluation. Tables 4.26 and 4.27 are the draft coding sheets for Raters 5 and 6. The raters labeled an "A" or "P" in the appropriate cell on the draft coding sheet. When the raters finished, they labeled and discussed their difference (see Table 4.32). In this analysis, there were fewer disagreements. The only characteristics that had K<81% was *Teachers understand how students learn and what are effective teaching strategies within a specific discipline*. The raters also found two emergent characteristics: (a) Has real world application, and (b) Improves communication skills. The results of the GK-12 content analysis are found in Table 4.33. The last two columns in the table list inter-rater reliability scores before and after the discussion. Within 36 hours of the second content analysis, raters were asked to repeat the procedure to check for intra-rater reliability. All intra-rater reliably scores were K>81%.

Lastly, Table 4.34 lists the ERBCPD, and the number of ERBCPD for each evaluation, the number of evaluations, and the percentage of characteristics present per evaluation. For example, the second characteristic on the list, *Treats teachers as professionals* appeared on 16 of 21 evaluations, or 76%. *Requires resources (money and time)* and *Teachers understand how students learn and what are effective teaching*

strategies within a specific discipline were also listed despite their low levels of agreement (Table 4.33).

Table 4.33: GK-12 Draft-Coding Sheet Results, Raters 5 and 6

	Characteristics	K before discussion	K after discussion
1	Teachers' discipline-specific knowledge is increased	0.62	1
2	~~Teachers understand how students learn and what are effective teaching strategies within a specific discipline~~	~~0.09~~	~~0.64~~
3	Teachers understand how students learn and what are effective teaching strategies	0.46	0.81
4	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked	-0.11	1
5	~~Requires resources (money and time)~~	~~0.35~~	~~0.35~~
6	Professional development is on-going	0.37	1
7	Professional development occurs in day-to-day contexts of teachers	0.06	1
8	Uses effective teaching strategies	0.09	1
9	Coherent/aligned with school/district/state goals	0.44	1
10	Teachers provide input into professional development design; professional development is engaging and relevant	0.35	1
11	Involves collaboration between teachers and others	0.15	1
12	Generates further collaboration or projects	0.58	1
13	Treats teachers as professionals	0.51	1
14	Promotes teacher self-reflection	0	1
15	Uses inquiry as a teaching style	0.62	1
16	Increases teacher ability to meet needs of diverse learners	0.30	0.86
17	Has real world application+	0.58	1
18	Improves communication skills+	0.81	1

* represents an emergent characteristic

Table 4.34: GK-12 Draft-Coding Sheet Results

	Characteristics	Number of char-acteristics present	Number of eval-uations	Percentage of char-acteristics per eval-uation
5	~~Requires resources (money and time)~~	~~17~~	~~18~~	94%
13	Treats teachers as professionals	16	21	76%
11	Involves collaboration between teachers and others	13	21	62%
6	Professional development is on-going	11	21	52%
18	Improves communication skills+	11	21	52%
7	Professional development occurs in day-to-day contexts of teachers	10	21	48%
1	Teachers' discipline-specific knowledge is increased	9	21	43%
8	Uses effective teaching strategies	8	21	38%
9	Coherent/aligned with school/district/state goals	8	21	38%
17	Has real world application+	8	21	38%
3	Teachers understand how students learn and what are effective teaching strategies	6	20	30%
12	Generates further collaboration or projects	5	21	24%
16	Increases teacher ability to meet needs of diverse learners	4	20	20%
10	Teachers provide input into professional development design; professional development is engaging and relevant	4	21	19%
2	~~Teachers understand how students learn and what are effective teaching strategies within a specific discipline~~	~~3~~	~~20~~	15%
15	Uses inquiry as a teaching style	3	21	14%
4	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked	2	21	10%
14	Promotes teacher self-reflection	1	21	5%

+ represents an emergent characteristic

Emergent Characteristics Descriptions

Two emergent characteristics were a product of the GK-12 content analysis. The first characteristic is *Has real world application*. It is interesting that the NSF Solicitation (2005) document makes no mention of real world application, yet the characteristic appears in many of the evaluations (see Table 4.34). Brown (2006) quotes a Fellow that believes the program provided "…real world applications and successful work opportunities" (p. 22). Balinsky et al. (2006) describe how a Fellow wanted to make a connection between the "…real world and the sometimes abstract, esoteric world of science" (p. 24). Williams's (2002) report makes four references to the real world, but none deal with the application to student learning. Most Fellows describe making a real work impact on others or getting experience in the real world.

The other emergent characteristic is *Improves communication skills*, which is an outcome of the GK-12 program (NSF, 2005). Williams's (2002) report makes many references to the improvement of communication skills. She states "…many science students felt their communication skills had also improved as a result of interacting with K–12 teachers and students" (p. xiv). The report states many of the Fellows participated in the program to improve their communication skills, and "[i]mproved communication skills were one of the main impacts that graduate students reported" (p. 46). Brown (2006) asked Fellows to write a reflective journal regarding their teaching experience. Many prompts were presented to the Fellows throughout the experience, but one prompt specifically mentioned to "[d]escribe one situation…this week when your communication skills were challenged, and the result" (p. 16). A constant comparative method was used

to analyze the journals (Strauss & Corbin, 1990). The data were reduced to core categories, none of which explicitly addressed communication skills. Balinsky et al. (2006) observed Fellows and asked them to write a chapter in a monograph (Gilmer et al., 2005). Findings from Balinsky et al. (2006) report that the Fellows improved their communication skills, and some of the Fellows report the same conclusion in their chapters (Gilmer et al., 2005).

Evaluations Linked to Student Achievement

Only four of the 21 GK-12 evaluations investigated student achievement. These evaluations came from institutions *a, e ,i,* and *,o* (See Tables 4.22 to 4.32). Institution *a* reported the percentage of 8th grade mathematic and science students that met the state standards in Fellows' classes versus control group classes. Results showed the Fellows' classes had a slight but insignificant increase in students passing science from 2002 to 2003, and a significant decrease in students passing mathematics from 2002 to 2003.

Institution *e* reported the percentage of students that improved or declined on 4^{th,} and 11th grade mathematics, and 5th, 8th, and 11th grade science state testing from 1998 to 2001. The evaluation compared the percentage of students in proficient/satisfactory categories to not proficient/not satisfactory. The control group was the district's pre-Fellow 1998 percentages, and the experimental group was the district's post-Fellow spring 2001 percentages. A z-test was used to determine whether the differences in student percentage for each category had changed significantly ($p>0.1$). On the 4th grade mathematics test, seven out of ten districts showed significant differences. Four of the

districts showed an increased in students receiving a satisfactory, whereas three of the districts decreased to non-satisfactory categories. Three out of ten districts revealed significant changes in the 11th grade mathematics test. Two of the districts increased student proficient scores, and one of the districts decreased towards not proficient. On the 5th grade science test, four out of ten districts exhibited significant changes. Three of the districts had students increase proficient scores, and one of the districts declined towards not proficient. On the 8th grade science test, two out of ten districts showed significant changes. Both districts had student scores that decreased to not proficient. On the 11th grade science test, five out of ten districts showed significant changes. Three of the districts increased students' proficient scores, and two of the districts moved towards not proficient. In all, Institution *e* had twelve districts that improved their proficiency scores, and nine schools that decreased their scores.

Institution *i* placed Fellows in 6th, 7th, and 8th grade mathematics classes and 8th grade science class from 2000-2003. For the 2000-2001 school year, students in mathematics classes with Fellows had passing scores of 90%, compared to control classes which were 84%. For the 2001-2002 school year, students in mathematics classes with Fellows had passing scores of 87%, compared to control classes which were 81%. For the 2002-2003 school year, students in mathematics classes with Fellows had passing scores of 86%, compared to control classes which were 80%. For the 2002-2003 school year, students in science classes with Fellows had passing scores of 95%, compared to control classes which were 86%.

Institution *e* did not used standardize testing because it used a engineering-based curriculum and created it own assessment. During the 2002-2003 school year, 1,139 pre-

and post-test were administrated to eight schools. The tests were based on 13 curricular units, and the evaluation depicts both groups scoring a 55% on the pretest. The scores on the post-test show the experimental group (Fellows' classrooms) scored 70% on the post-test versus the control group (classes without Fellows) which scored a 59%.

Summary

This chapter answers the three research questions and describes the study's findings. The answer to the first question, *What are the effective research-based characteristics of professional development?*, is found on Table 4.19. The answer to the second question, *What are the effective research-based characteristics of professional development of the GK-12 program?*, is found on Table 4.34. The answer to the third question, *What are effective research-based characteristics of professional development of the GK-12 program that are not answered by Question One? Why are these characteristics not mentioned?*, is found at the bottom of Table 4.33 (see characteristics 17 and 18) and the following section. The chapter also reports GK-12 student achievement data.

Chapter 5

Discussion, Implications, and Further Research

Introduction

The purpose of this study was to create descriptions of ERBCPD related to student learning and teacher behavior, and to use these descriptions to investigate ERBCPD of the GK-12 program. This answers the three research questions: (a) What are the effective research-based characteristics of professional development? can be found in Table 4.19; (b) *What are the effective research-based characteristics of professional development of the GK-12 program?* can be found in Table 4.34; and (c) *What are effective research-based characteristics of professional development of the GK-12 program that are not answered by Question One? Why are these characteristics not mentioned?* can be found on page 103.

The following chapter illustrates the formal descriptions from the content analyses and provides studies where the characteristics have been related to student achievement, the nature of educational research in a postmodern world, the need for guidance in designing and implementing professional development, and ideas for further research in both professional development and GK-12.

Discussion

This section will illustrate the ERBCPD and support nearly each one with studies where the characteristics have been related to student achievement. Some of the characteristics will not be supported because they are ancillary characteristics of a program as opposed to the central effort. For example, the characteristic *generates further collaboration and projects*, is often not the main outcome of professional development. Therefore, it is difficult to find studies that link this characteristic to student achievement.

A strong word of caution to the reader: although the following studies seem to show a relationship between a characteristics and student achievement, it is impossible to state the characteristic directly caused the improvement in student achievement. Each of the following studies has multiple ERBCPD which probably also influenced student achievement. What is true is that we will never be able to directly link student learning to even one ERBCPD by experimental design from a positivistic/post-positivistic paradigm. One of the experts interviewed stated "…strong evidence to show that any of these [ERBCPD] are related directly to specific improvement in student learning outcomes…would be…difficult to agree to." It is because it is impossible to isolate every factor, with the exception of the independent variable, which may contribute to student achievement. It is an instance where the uncertainty principle transcends the natural sciences and becomes a property of social science experimentation. Not only will we not have the ability to directly link student learning to an ERBCPD by experimental design, today, but this will probably never occur. A post-positivist would state one can

only get so close to "truth" by continuous research and experimentation, but one may never reach it.

Teachers' discipline-specific knowledge is increased

Most educational stakeholders believe mastery of content knowledge is a very important aspect of effective teaching. Nearly every list represented on the ERBCPD draft coding sheets (Table 4.2 to 4.8) has shown a presence of the enrichment of content knowledge. Paradoxically, the research in the relationship between teacher content knowledge and student achievement is not as strong and consistent as many believe it to be (Darling-Hammond, 1999). Most studies do show a weak correlation between student achievement and teachers' content preparation. For example, Monk (1994) using data on 2,829 students from the Longitudinal Study of American Youth, found a positive correlation between teachers' science and mathematics coursework and student achievement. In a study investigating reading in professional development, McCutchen, Abbott, Green, Beretvas, Cox, Potter, Quiroga and Gray (2002) studied two groups of first and second grade teachers. One group received professional development that enriched their knowledge of word sounds and structure. The other group, the control group, did not receive this treatment. The teachers from the experimental group had students who scored significantly higher on reading, spelling, and comprehension exams.

Teachers understand how students learn and what are effective teaching strategies within a specific discipline

Shluman (1986) describes the idea of PCK, and its importance for instruction; unfortunately, most professional development endeavors do not address PCK. It is important for teachers to understand the connection between content knowledge and pedagogical knowledge (Darling-Hammond, Ancess, & Falk, 1995). The idea of a teacher connecting pedagogical and content knowledge is something that has been shown to be successful for sometime. Perkes (1967-1968) found teachers that had only coursework in the sciences were not significantly related to student achievement, but did find teachers that had coursework in science education were significantly related to student achievement. Begle (1979) reviewed findings of the National Longitudinal Study of Mathematical Abilities and found teachers with a higher number of mathematics education courses were stronger correlated to high student achievement scores than any other indictors of preparation, including mathematics content courses.

Carpenter, Fennema, Peterson, Chiang, and Loef (1989), developed a professional development program that focused on the integration of student learning and subject matter. The researchers randomly assigned a group of first grade teachers to a month long workshop. One group studied how students understand and solve addition and subtraction word problems, while the other group studied mathematical problem-solving strategies but not how the students understand the mathematics. Results of the study showed teachers who participated in the student-centered intervention were more likely to listen to their students' problem solving processes, give more complex problems to students, and ask students to seek multiple methods in order to solve mathematical

problems. Teachers in the other workshop emphasized quick answers, recall, and working alone rather than collaboratively. The student-centered group had higher student achievement scores and greater growth in students' reasoning and problem-solving skills than the other group.

Teachers understand how students learn and what are effective teaching strategies

Research has shown that teachers' that have an understanding of how students learn and strong pedagogical knowledge can improve student achievement (Darling-Hammond, 1997b; Gardner, 1989, Hammond & McLaughlin, 1995; Hansen, 1988; Perkes, 1967-68; Skipper & Quantz, 1987). Results from the 1994 National Assessment of Educational Progress testing showed that teachers who had more work in pedagogical knowledge were associated with higher student achievement scores than those with less work. Guyton and Farokhi (1987) compared the influences of different kinds of knowledge on 12 dimensions of teacher performance. Over 270 teachers were observed with a standardized performance instrument, and results showed a positive correlation between the amount of pedagogical coursework and improved teacher instructional behavior.

Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked

Educational leaders should continuously use student data to guide professional development activities since the goal of professional development is to enrich student

learning (American Educational Research Association [AERA], 2005; Elmore, 2002; Guskey, 2000; Sanders, & Rivers, 1996; and Speck & Knipe, 2005). Most states, districts, and agencies are unaware of what they are getting out of their professional development endeavors because they do not systemically evaluate their programs; these evaluations should include evidence of student learning (AREA, 2005)

A district implemented a professional development program called *Read to Succeed*, which focused on consistent student achievement evaluation on a variety of reading related measures. Twelve sections from several schools received 10-15 days of the intervention. All of the teachers' students (N≈300) made gains on either the vocabulary, comprehension, or both subtests of the Canadian Tests of Basic Skills. A similar program is *Success for All*, a program that emphasizes an intensive reading curriculum with systematic evaluations of learning problems and immediate intervention. The effects for *Success for All* include reduction of retention and gains in reading across a variety of student achievement tests (Hurley, Chamberlain, Slavin, & Madden, 2001).

Requires resources (money and time)

Although time and money are important aspects of professional development, they must be used correctly (AERA, 2005; Ferguson, 1991). Elmore (2002) states most school systems do not know how to properly use professional development funds because their design infrastructure is flawed to begin and not structured on the enrichment of student learning. The same can be said of time. While adequate time is intuitive and essential for professional development, additional time does not guarantee success

(AERA, 2005). If activities are not research-based, time will do little to enrich student learning (AERA, 2005).

If used correctly, time and money do aid in professional development. In the mid 1980s, North Carolina and Connecticut made the most substantial monetary investments in education (Darling-Hammond, 1999). Funds were directed toward professional development, teacher mentoring, and preservice teacher education among other programs. In the late 1980s, North Carolina posted the largest achievement gains in mathematics and reading of any state in the nation, and Connecticut had significant gains in student achievement (National Center for Education Statistics [NCES], 1994).

Uses effective teaching strategies

Professional development should include effective teaching strategies. This idea has been mentioned for the third time in this list, therefore it can be assumed it is an important characteristic. Teachers who have had formal preparation are more likely to use effective teaching strategies, and therefore address multiple learning styles and encourage higher order thinking of students (Perkes, 1967-68; Skipper & Quantz, 1987; Hansen, 1988). Studies will not be used to support this characteristic because it is too generic, and as one expert said, "…a slippery slope."

Coherent/aligned with school/district/state goals

The goal(s) of professional development must align with school, district, and state standards and outcomes (Joyce & Showers, 1995). The alignment creates an environment where teachers have a better chance to "buy-in" to the program, take

ownership, and create strong arguments for additional resources. Research has shown professional development that is aligned with goals and standards leads to better instruction, and improved student learning (AERA, 2005).

Cohen and Hill (2001) studied teachers that took part in a professional development endeavor that focused on alignment with district and state standards. The researchers found that teachers who focused on the curriculum they were to teach, were more likely to bring their experiences from the professional development activities to the classroom. The study found that teachers who participated in the professional development had student that faired well on new state-required assessments.

Increases teacher ability to meet needs of diverse learners

Effective teachers have the ability to meet the needs of diverse learners by adjusting their teaching styles, yet addressing instructional goals, topics, and methods (Doyle, 1985). Hamachek (1969) found that successful teachers were those who used a variety of interactions and strategies. This finding aligns with the research that shows that no single instruction style is unvaryingly successful (Darling-Hammond, 1999; Gardner, 1989).

The San Francisco Unified School District (SFUSD hereafter) is a district that works with 64,000 students who speak 39 different languages and come from various social-economic statuses. SFUSD implemented a professional development endeavor that could address its students' needs, while focusing on improving student achievement in core academic areas. The district created a package of professional development workshops in which schools could tailor professional development and resources to their

specific needs. Since the inception of the program, reading and mathematics scores have increased significantly for three consecutive years (U.S. Department of Education, 1998).

Involves collaboration between teachers and others

Collaboration is an important aspect of professional development (Speck & Knipe, 2005) and is important for teachers if they are to become life long learners (Dalheim, 1994). Collaboration means teachers, administrators, parents, and students are to work together in designing, planning, implementing, reviewing, revising, and evaluating professional development (Speck & Knipe, 2005). The reason many professional development experiences fail to enrich teacher learning (NRC, 2000) is because they do not address teachers' needs (Barufaldi, 1987; Feldman & Kropf, 1997). Many researchers and groups, including the Texas Regional Collaboratives at The University of Texas at Austin, are currently studying collaboration that address teachers' needs, and its impact on student learning (Barufaldi & Reinhartz, 2001).

One program that focused on organizing faculties for collaborative action is the River City School Improvement Program (the location of the schools is not provided). A condition of the program was that 80% of the faculty had to agree to participate in all major improvement decisions. The faculties were organized into councils which examine information about the state of the school and planned school improvement initiatives (Joyce, Murphy, Showers, & Murphy, 1989). Achievement scores gains were apparent as 70% of the students made promotion at the end of the first year and 95% earned promotion the end of the second year.

A word of caution on collaboration; although collaboration is found to be important for high quality professional development, it has also shown to hamper growth. For example, Corcoran (1995) found that collaboration does not always work because teachers may try to resist change. One of the experts commented that teachers sometimes do not know what they need in order to improve student achievement. For example, a teacher may believe he needs professional development in classroom management, whereas the real problem may lie in poor lesson planning that does not engage students. If the lessons were more engaging, there would be less classroom management issues.

Promotes teacher self-reflection

Reflection is an important aspect of learning and its significance in cognition can be traced back to Locke. Cooper (1999) states that reflection is the decision-making systems' method for self-correction that adds to one's understanding, and to the planning of future decisions. Schon (1987) states that reflection is a paramount characteristic of professional development and an important action for practitioners.

One study that investigated the impact of reflection upon student achievement was conducted over two years with 18 intermediate (students' age from 11-13) and secondary teachers (Britt, Irwin, & Ritchie, 2001). Teachers collaborated to improve their mathematics' teaching through reflection of their practices with minimal support from the researchers. Gains were measured by student achievement among other forms of evaluation. Findings showed that the experience was beneficial for experienced secondary teachers but less effective for intermediate school teachers. The researchers concluded the intervention was most helpful to teachers with a strong content knowledge

background because the teachers were able to draw connections between pedagogy and the subject matter.

Uses inquiry as a teaching style

Inquiry is the approach teachers of science are recommended to use in order to teach science (NRC, 1996a). Inquiry is not emphasized in other disciplines such as mathematics, socials studies, and language art, although it can be used in appropriate instances. Many research studies have described the impact of inquiry in professional development and its influence on student learning. Alouf and Bentley (2003) studied two professional development programs in Virginia that implemented summer institutes focused on teachers participating in inquiry-based activities. The expectation was the teachers would use inquiry in their own classrooms. The activities conducted in the workshop were open-ended and related to the work scientists do versus the pedestrian cookbook science laboratory with predictable outcomes. Results showed students' of teachers who had the workshop had gains in student achievement, problem solving, teacher-made tests, and recall of content (Alouf & Bentley, 2003).

Science resource teachers in South Carolina designed an NSF funded professional development program which used an inquiry-based science curriculum and the use of science notebooks (Mintz, & Calhoun, 2004). The findings showed an increase in student achievement. Another inquiry-based professional development program was implemented in a high school in Israel (Hofstein, Shore, & Kipnis, 2004). The goal of the program was to introduce teachers to working with students in order to learn

chemistry in an authentic environment. An analysis of the student work clearly revealed an improvement in inquiry abilities.

Treats teachers as professionals

There are very few studies where professional development programs are built upon the notion of treating teachers as professionals, and even fewer studies that link the characteristic to improvements in student learning. Nevertheless, this characteristic is one that has been historically important to teachers. For years, debates occurred whether teachers were considered professionals. Today, most believe teachers to be professionals, but some ambivalence still lingers (Bezeau, 1995).

Rich (1984) describes the characteristics of a profession as:

1. requiring a high degree of general and systematized knowledge
2. requiring a long period of specialized intellectual training
3. characterized by work that is essentially intellectual
4. providing a unique social service
5. controlling its standards of entrance and exclusion
6. developing and enforcing a professional code of ethics
7. granting practitioners a broad range of autonomy

(Rich, 1984, p. 8-11)

Although no profession fulfills every characteristic, teachers often rank low on the fifth point and medium on the second and seventh characteristics (Bezeau, 1995). To counter this, educational leaders can empower teachers and create a culture where their professionalism is developed (Sparks & Hirsh, 1997). One method of achieving this is

using inside expertise of teachers as an integral part of professional development (NRC, 1996a; Speck & Knipe, 2005) and using teacher input to create and develop professional development.

Generates further collaboration or projects

Once again, this characteristic is not one that a professional development program would be centered upon but is considered more of an ancillary characteristic. Therefore, it is difficult to find any work that has linked this characteristic to student learning. Champion (2006) reports professional development with no milestones or markers may blur the purpose of follow-up, despite prior successes. Incidentally, this characteristic may be considered one of the outcomes of the GK-12 program. The GK-12 solicitation program states the partnerships between institutions of higher education and local school districts should be strengthened (NSF, 2005). It is hoped these collaborations would be sustained and continued without the support of NSF by additional human and financial resources. A few of the GK-12 evaluations do mention notions of sustainability. For example, one evaluation states the institution will continue weekend activities with the local school and community.

Professional development is on-going

Professional development occurs in day-to-day contexts of teachers

These two characteristics have much in common so they will be described together. Professional development that is meant for change must be ongoing (Speck & Knipe, 2005) and occur on a day-to-day basis. It should be long enough to allow teachers

to change their practices, improve student achievement (Darling-Hammond, 1997b; Fullan & Stiegelbauer, 1991; Joyce & Showers, 2002), and contextualized for authenticity (Darling-Hammond & Snyder, 2000).

One school district that focused on both these characteristics was the high performing Mountain Brooks School District in Birmingham, Alabama. The district created and developed a culture where professional development was ongoing, day-to-day, and relevant to teachers (Newman, 2006). The school aligned their professional development with NSDC's standards (2001) which emphasized student learning through continuous professional development. The program included one faculty meeting per month, planning periods for teachers throughout the week, and small group meetings to discuss curriculum, instruction, and coplanning (Newman, 2006). The outcomes of the experience exhibited continual student growth in mathematics and writing scores on standardized testing over a number of years.

Teachers provide input into professional development design; professional development is engaging and relevant

Activities become meaningful to teachers when educational leaders meet teachers' needs with professional development (Lieberman & Miller, 1999). It is difficult for teachers to focus on mandated professional development when their own needs are not met (Speck & Knipe, 2005). Teachers, to some extent, need to be involved in planning, implementing, reviewing, and evaluating professional development; otherwise they may not commit to the endeavor (Darling-Hammond & McLaughlin, 1995).

Corcoran (1995) states that teachers are often not included in many of these aspects of professional development.

A school in Pittsburgh, Pennsylvania was determined to create a professional development program that had teachers working in equal partnership with administrators and university researchers (Hubbard, 2002). Mathematics teachers worked with researchers in order to improve student achievement scores and developed a program known as *Cognitive Tutor*; a software package that claims to construct a profile of the learner's mathematics understanding. After the program was introduced to the school, the teachers were responsible for evaluating the software and reporting their feedback to the researchers. Findings illustrated that the teachers embraced the endeavor, and students' improved mathematics classroom achievement scores.

Has real world application

Many are concerned with the issue of what is learned in school of having real world application. Content is often reduced and disembodied from situations students encounter in their daily lives. One method that has shown to aid in real world application is "situation cognition". Situated cognition is conceptual learning which takes place in activities that are not void of context (Brown, Collins, & Duguid, 1989). Goldman, Hasselbring, and the Cognition and Technology Group at Vanderbilt (1996) state that if we intend on having students solve complex, everyday problems, we must provided these situations in school. One well known situated cognition experiment is Bart's Pet Project (Bottge & Hasselbring, 1993). This real world problem, or *anchor*, is presented on video and explains to the students that a boy named Bart wants to buy a reptile and build a cage

for the animal. The video is an eight minute explanation of the situation and asks students to sort relevant versus irrelevant information in order to solve the problem. Results of the study showed that students in experimental groups were more likely to transfer the processes used to solve the problem to new situations.

Improves communication skills

This characteristic could be included in: *Teachers understand how students learn and what are effective teaching strategies* and *Uses effective teaching strategies*. Simply improving communication skills seem very teacher-based instead of student-based. A better title for this characteristic may be to improve communications skills and understand how students learn. This difference may be the reason that there are scarce studies in simply linking professional development that concentrates on improving communication skills to student achievement. In the field of education, the improvement of communication skills is seen differently than teaching. For example, the Maryland Professional Development Standards (based on NSDC, 2001) mention improving communication skills but in the context of communication with parents and the community.

Implications

The adoration of science in America probably reached its apex during the early 1960s (Gall, 1996). Science had given the country the ability to create the atomic bomb, provide cures for disease, and aid business with its advances in technology. Many

believed science and its methodology could be used to solve serious social issues including defeating communism, eliminating poverty, and improving health care (Gall, 1996). This philosophy of science is often referred to as *technocratic rationality*, and is believed by many to be the highest form of knowledge and truth (Schon, 1983). As science and its methodology were applied to social issues, it became apparent that science was not as helpful as many believed it to be and the notion of technocratic rationality somewhat dissipated. In the end, science did not end racism, communism, poverty, or cure cancer (Gall, 1996). The product of this disappointment called into doubt many positivistic views of science, and was further challenged by work in quantum theory, systems theory, and Popperian Falsificationism.

There is a deep-seated difference in this country's attitude and beliefs of the natural sciences versus the social sciences, and this difference permits the American educational system to idle in peril. The problem, as this researcher sees it, is when one talks to others about ideas and theories in the natural sciences, one usually does not disagree with these ideas unless it clashes with one's belief system. Examples include creationists who do not believe in the theory of evolution, Flat Earth Society members who challenge the notion of an oblate spheroid earth, and many environmentalists who believe that the loss of one or more species will severely disrupt or destroy an ecosystem. Alternately, everyone seems to have one's own anecdotal ideas on the social sciences. Everyone seems to think she knows how to "fix it." "It" may be schools, poverty, psychotherapy, or crime and punishment. We do not see many of the same individuals arguing for how to cure cancer, discover a grand unified theory, or explain the mechanism for the movement of tectonic plates; all domains of the natural sciences.

If one would like to radiometrically date a mineral, there are many strict procedures that one should follow. Years upon years of research have been conducted and accepted on how to best date minerals, and geologists use these procedures when dating. If one was to date a mineral without using these procedures and supporting theories, the scientific community would cast doubt upon the findings of the individual. Alternately, there are many strong evidence-based procedures and theories for work in the social sciences, and the population does not seem to be aware of these procedures and theories. A simple experiment is to ask any educator what is her theory of learning, or how does one come to understand something? If this question was asked of most in education (this includes teachers, administrators, professors, and educational leaders) most would not know how to begin to answer the question. Most would give anecdotal ideas about how people learn. An ironic instance of this is found in one GK-12 evaluation in which the PI, who is a full professor in a science, describes the systematic, meticulous, evidence-based nature of scientific work and the work of his field, yet he merely designs, implements, and evaluates his program in an anecdotal fashion.

The major implication from this study is that educational leaders need research-based guidance in designing and implementing professional development. Educational leaders often use anecdotal approaches to what they believe to be effective professional development practices. This was witnessed first hand by this researcher at both schools in which he was employed and the GK-12 sites he studied. This is not the fault of the educational leaders but of those who educate and provide direct support to these leaders. We cannot assume STEM professors know how to properly implement, design, and evaluate professional development. For example, of the 16 ERBCPD (this doesn't

include the two stricken characteristics) only five appeared in at least half of the evaluations and one characteristic, *Promotes teacher self-reflection*, appeared only once out of 21 evaluations (see Table 4.34). Therefore, NSF should provide more guidance and support to PIs and schools of education should communicate the idea (in a proper research-based fashion) to future educational leaders that effective research-based professional development exists.

One other implication of this study is the issue of evaluation. Based on the findings of this study, only four programs used student achievement scores for evaluation despite one of the GK-12 solicitation program's stated outcomes, which is to enrich learning for K-12 students (NSF, 2005). The GK-12 program has more outcomes than this, but proper evaluation of student learning should be included in every program to some extent.

Although this final implication has since been addressed by NSF, it is important to mention in 1999 PIs wrote their own evaluations. Currently, NSF required PIs to have their evaluations conducted by external evaluators which makes the evaluations more powerful and subtracts many of the biases mentioned the in the *Limitations* section.

Further Research

There must be continual research in GK-12 in order to understand if the program is effective. There has been little published material on GK-12 and just about any type of high-quality research would be beneficial. For example, are Fellows learning to teach in

a research-based fashion? Are Fellows enriching their PK, PCK, and nature of science understanding? How are the mentor teachers benefiting from the program? Do the university-school collaborations truly sustain after the program's ends? To what degree do they sustain and in what ways?

Further research is needed for ERBCPD for different contexts. This study's list of ERBCPD is a "one size fits all" list. This is dangerous because most of the lists from the literature reviews concentrated on science and mathematics. For example, inquiry is an ERBCPD. Inquiry is the approach science teachers use to have students understand scientific concepts, just as problem solving is the approach mathematics teachers use to have students understand mathematical concepts. Inquiry is sometimes but generally not used in disciplines outside of science. Just as schools of education have different programs (science education, literary education, special education, urban education), so should ERBCPD lists. Good research questions would be, what are the ERBCPD for; (a) middle school social studies teachers; (b) high school history teachers; and (c) elementary special education teachers. Until the ERBCPD reflect the context of the students and the school, the list may be too generic to apply.

More research is needed in linking ERBCPD to student achievement. Any high-quality research in this domain would benefit the educational field. Traditional quantitative experimental approaches can be used to further understand if a link occurs between any of the ERBCPD and student achievement.

Conclusions

The purpose of this dissertation was to create descriptions of ERBCPD related to student learning and teacher behavior, and to use these descriptions to investigate the GK-12 program. After three content analyses, inter- and intra-reliability testing, and expert validity interviews the study yielded; (a) 16 ERBCPD; (b) the incorporation of all of the ERBCPD in the GK-12 program, but to drastically varying degrees; and (c) two emergent GK-12 characteristics. This chapter describes 18 (including the two "stricken") characteristics of professional development and supports nearly all of the characteristics with research-based studies. Some of the characteristics have strong connections to student learning, while others are more difficult to link. It is hoped that through additional research, stronger connections can be made to student learning. We can only hope that one day our educational system will be supported with high-quality, research-based, effective professional development to guide educational leaders in their professional development endeavors.

Appendices

Appendix A

GK-12 Fellow Informed Consent Form

IRB#2004-10-0127

Informed Consent to Participate in Research

The University of Texas at Austin

You are being asked to participate in a research study. This form provides you with information about the study. The Principal Investigator (the person in charge of this research) will also describe this study to you and answer all of your questions. Please read the information below and ask questions about anything you don't understand before deciding whether or not to take part. Your participation is entirely voluntary and you can refuse to participate without penalty or loss of benefits to which you are otherwise entitled.

Title of Research Study:
Exploring the Development of GK-12 Fellows

Principal Investigator(s) (include faculty sponsor), UT affiliation, and Telephone Number(s):
PI: Pete Cormas, School of Education gradate student, 517-0215
Faculty Sponsor: Julie Luft, Ph.D., 232-6204

Funding source:
There is no funding source.

What is the purpose of this study?
A huge investment in public funding has been dedicated to the implementation of the National Science Foundation's Graduate Teaching Fellows in K-12 (GK-12) program. The National Science Foundation has awarded the Environmental Science Institute at The University of Texas at Austin a grant to partner graduate students in the sciences with K-12 teachers in Texas to enhance science education through new classroom activities, workshops and field projects. During the semester, we will be conducting a study to understand how the program impacts two Fellows development as a teacher of science. Specifically, we are interested in understanding the change that Fellows experience in their beliefs, practices, and knowledge bases.

What will be done if you take part in this research study?

If you agree to participate, you will be asked to consent to two interviews about your pedagogical philosophies and content knowledge, complete an interview about your views of teaching science, fill out a personal questionnaire, and be observed weekly and contacted three times during the year to discuss your classroom instruction. The interviews and questionnaires will take approximately 4-5 hours at the beginning and end of the semester, and will be audio-taped. During the classroom visits, notes will be made about your teaching. Following the visits or during another time, you will be asked about your other lessons during the week. Other than scheduling the visit, talking about your instruction, and possibly collecting materials about the lessons, there will not be additional time.

What are the possible discomforts and risks?
There are no discomforts or risks that are associated with this study.

What are the possible benefits to you or to others?
Presently there has been very little research on GK-12 Fellows. There is a need to create a knowledge base regarding the development of GK-12 Fellows. This knowledge base will ultimately impact the design of similar programs, and fill a void in the research pertaining to such NSF funded programs. .

If you choose to take part in this study, will it cost you anything?
There is cost to you if you decide to become involved in this study.

Will you receive compensation for your participation in this study?
There is no compensation for your participation in this study.

What if you are injured because of the study?
No provisions have been made to provide treatment or medical care for any research related injury. No arrangements have been made to provide for payment for any research related injury. If injuries occur as a result of study activity, eligible University students may be treated at the usual level of care with the usual cost for services at the Student Health Center, but no payment can be provided in the event of a medical problem.

If you do not want to take part in this study, what other options are available to you?
Participation in this study is entirely voluntary. You are free to refuse to be in the study, and your refusal will not influence current or future relationships with The University of Texas at Austin and or participating sites such as AISD or any other organization.

How can you withdraw from this research study and who should I call if I have questions, complaints, or concerns?
If you wish to stop your participation in this research study for any reason, you should contact: Pete Cormas at (512) 517-0215. If for any reason you cannot contact the principle investigator or need to speak with someone further please contact the Office of Research Support & Compliance or Institutional Review Board Chair listed below. You are free to withdraw your consent and stop participation in this research study at any time without penalty or loss of benefits for which you may be entitled. Throughout the study, the researchers will notify you of new information that may become available and that might affect your decision to remain in the study.

In addition, if you have complaints, concerns, or questions about this or any other study, or your rights as a research participant, please contact The Office of Research Support and Compliance or Clarke A. Burnham, Ph.D., Chair of The University of Texas at Austin Institutional Review Board for the Protection of Human Subjects, (512) 471-8871 / (512) 232-4383 / orsc@uts.cc.utexas.edu.

How will your privacy and the confidentiality of your research records be protected?
Authorized persons from The University of Texas at Austin and the Institutional Review Board have the legal right to review your research records and will protect the confidentiality of those records to the extent permitted by law. Your research records will not be released without your consent unless required by law or a court order.

If the results of this research are published or presented at scientific meetings, your identity will not be disclosed.
This study involves interviews or sessions that will be audio taped. Cassettes will be coded so that no personally identifying information is visible on them. The cassettes will be kept in a secure place (the investigator's home) and will be heard or viewed only for research purposes by the investigator and his associates. The cassettes will be kept because of the requirements of the investigator's professional organization with respect to data and because the investigator may wish to review them for additional analyses at a later time.

"We may wish to present some of the tapes from this study at scientific conventions or as demonstrations in classrooms. Please sign below if you are willing to allow us to do so with the tape of your performance."

Signature and printed name of person obtaining consent **Date**

"I hereby give permission for the audio tape made for this research study to be also used for educational purposes."

Signature and printed name of person obtaining consent

Date

Will the researchers benefit from your participation in this *study?*
The researchers of this study will not benefit monetarily or otherwise, beyond publishing or presenting the results.

Signatures:

As a representative of this study, I have explained the purpose, the procedures, the benefits, and the risks that are involved in this research study:

Signature and printed name of person obtaining consent

Date

You have been informed about this study's purpose, procedures, possible benefits and risks, and you have received a copy of this Form. You have been given the opportunity to ask questions before you sign, and you have been told that you can ask other questions at any time. You voluntarily agree to participate in this study. By signing this form, you are not waiving any of your legal rights.

Printed Name of Subject

Date

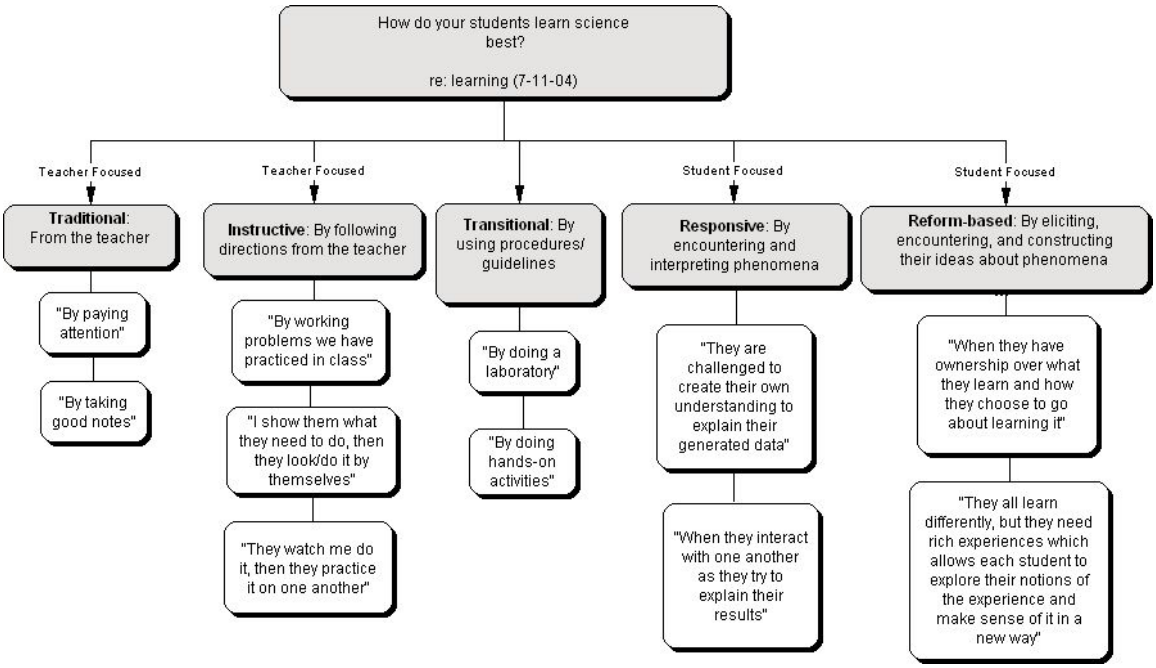
Signature of Subject **Date**

Signature of Principal Investigator **Date**

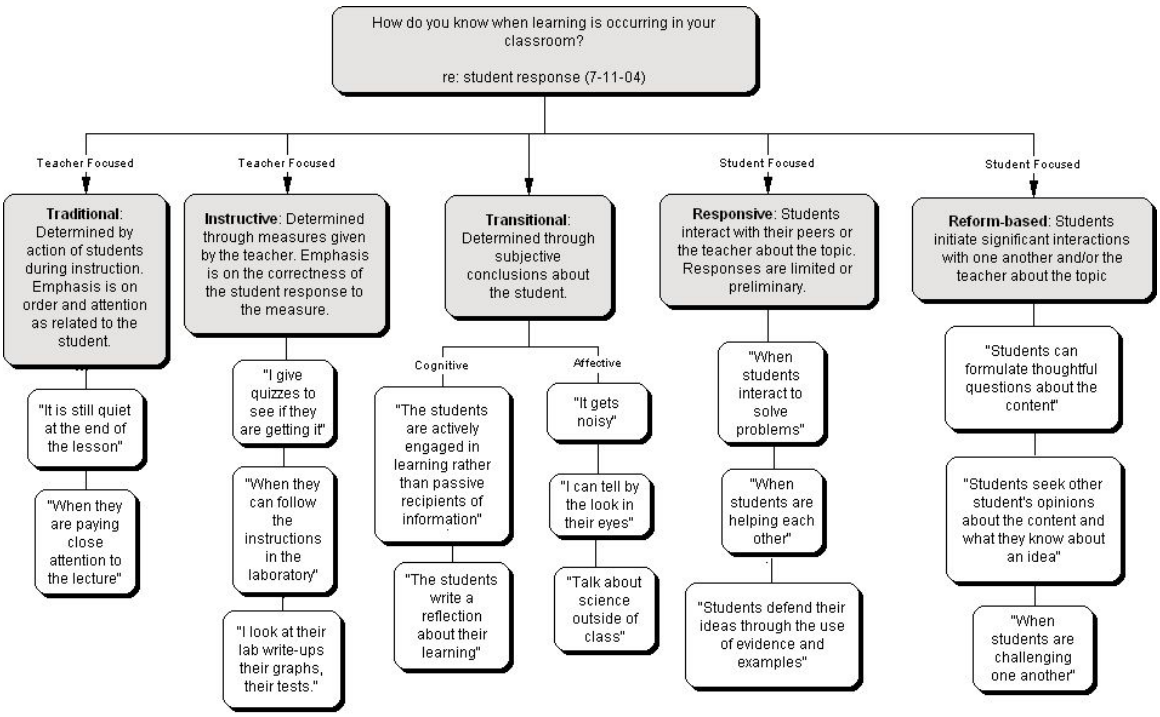
Appendix B

Interview Maps

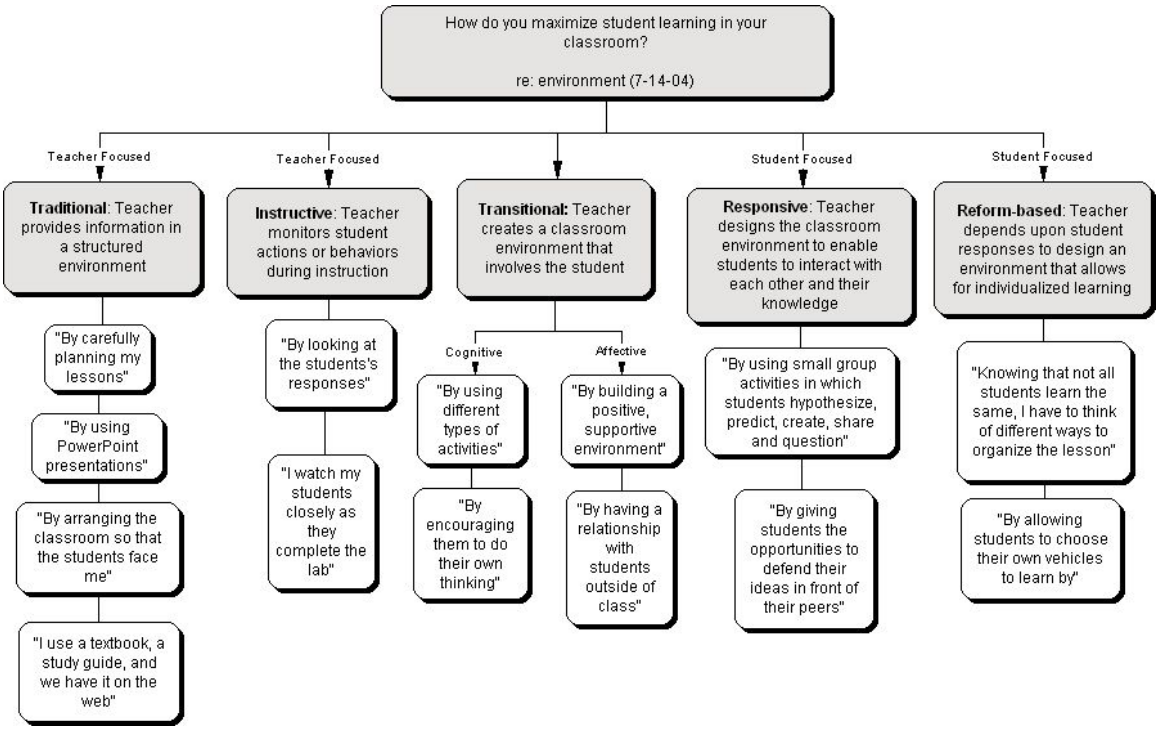
1


How do your students learn science best?
re: learning (7-11-04)
Teacher Focused
Traditional: From the teacher
"By paying attention"
"By taking good notes"
Teacher Focused
Instructive: By following directions from the teacher
"By working problems we have practiced in class"
"I show them what they need to do, then they look/do it by themselves"
"They watch me do it, then they practice it on one another"
Transitional: By using procedures/ guidelines
"By doing a laboratory"
"By doing hands-on activities"
Student Focused
Responsive: By encountering and interpreting phenomena
"They are challenged to create their own understanding to explain their generated data"
"When they interact with one another as they try to explain their results"
Student Focused
Reform-based: By eliciting, encountering, and constructing their ideas about phenomena
"When they have ownership over what they learn and how they choose to go about learning it"
"They all learn differently, but they need rich experiences which allows each student to explore their notions of the experience and make sense of it in a new way"

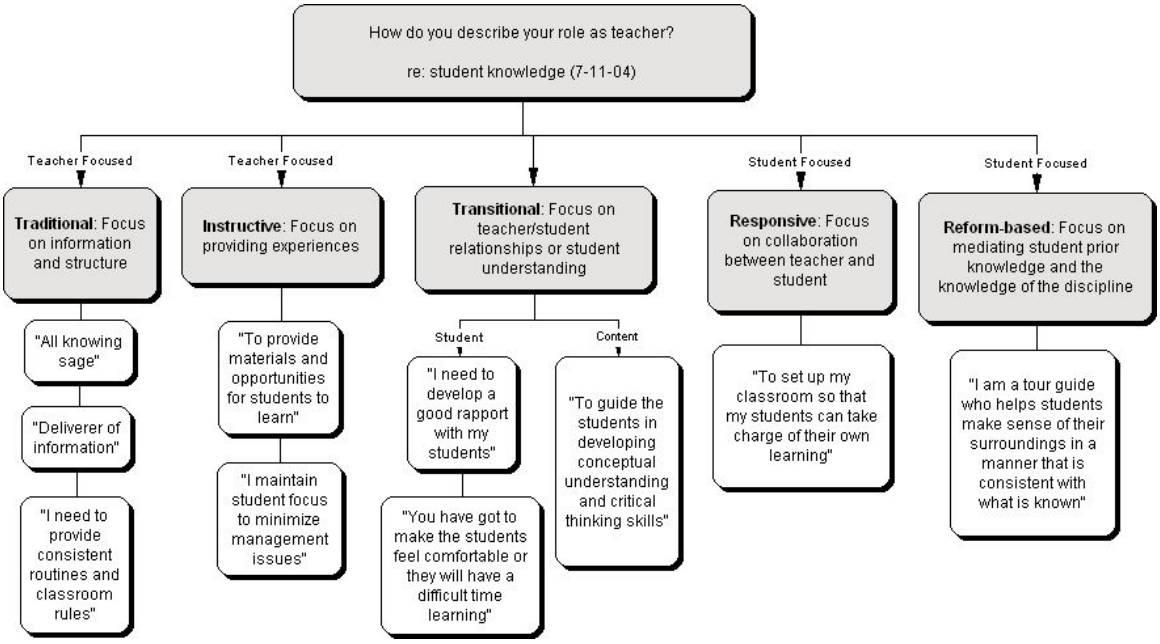
2


How do you know when learning is occurring in your classroom?
re: student response (7-11-04)
Teacher Focused
Traditional: Determined by action of students during instruction. Emphasis is on order and attention as related to the student.
"It is still quiet at the end of the lesson"
"When they are paying close attention to the lecture"
Teacher Focused
Instructive: Determined through measures given by the teacher. Emphasis is on the correctness of the student response to the measure.
"I give quizzes to see if they are getting it"
"When they can follow the instructions in the laboratory"
"I look at their lab write-ups their graphs, their tests."
Transitional: Determined through subjective conclusions about the student.
Cognitive
"The students are actively engaged in learning rather than passive recipients of information"
"The students write a reflection about their learning"
Affective
"It gets noisy"
"I can tell by the look in their eyes"
"Talk about science outside of class"
Student Focused
Responsive: Students interact with their peers or the teacher about the topic. Responses are limited or preliminary.
"When students interact to solve problems"
"When students are helping each other"
"Students defend their ideas through the use of evidence and examples"
Student Focused
Reform-based: Students initiate significant interactions with one another and/or the teacher about the topic
"Students can formulate thoughtful questions about the content"
"Students seek other student's opinions about the content and what they know about an idea"
"When students are challenging one another"

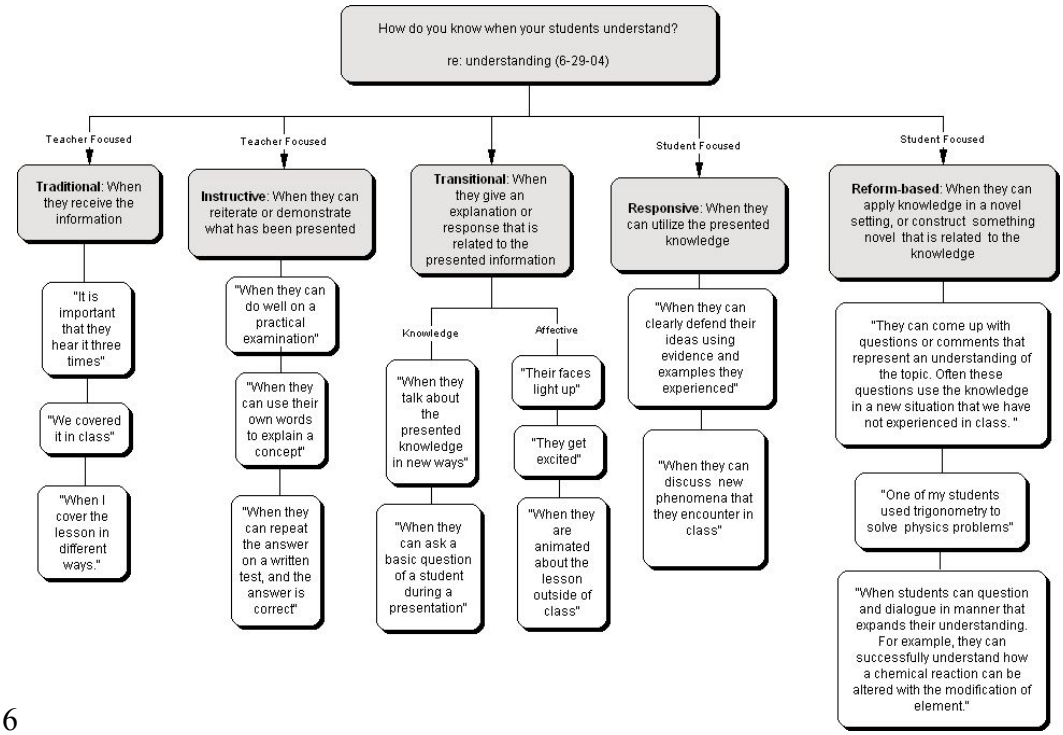
3


How do you maximize student learning in your classroom?
re: environment (7-14-04)
Teacher Focused
Traditional: Teacher provides information in a structured environment
"By carefully planning my lessons"
"By using PowerPoint presentations"
"By arranging the classroom so that the students face me"
"I use a textbook, a study guide, and we have it on the web"
Teacher Focused
Instructive: Teacher monitors student actions or behaviors during instruction
"By looking at the students's responses"
"I watch my students closely as they complete the lab"
Transitional: Teacher creates a classroom environment that involves the student
Cognitive
"By using different types of activities"
"By encouraging them to do their own thinking"
Affective
"By building a positive, supportive environment"
"By having a relationship with students outside of class"
Student Focused
Responsive: Teacher designs the classroom environment to enable students to interact with each other and their knowledge
"By using small group activities in which students hypothesize, predict, create, share and question"
"By giving students the opportunities to defend their ideas in front of their peers"
Student Focused
Reform-based: Teacher depends upon student responses to design an environment that allows for individualized learning
"Knowing that not all students learn the same, I have to think of different ways to organize the lesson"
"By allowing students to choose their own vehicles to learn by"

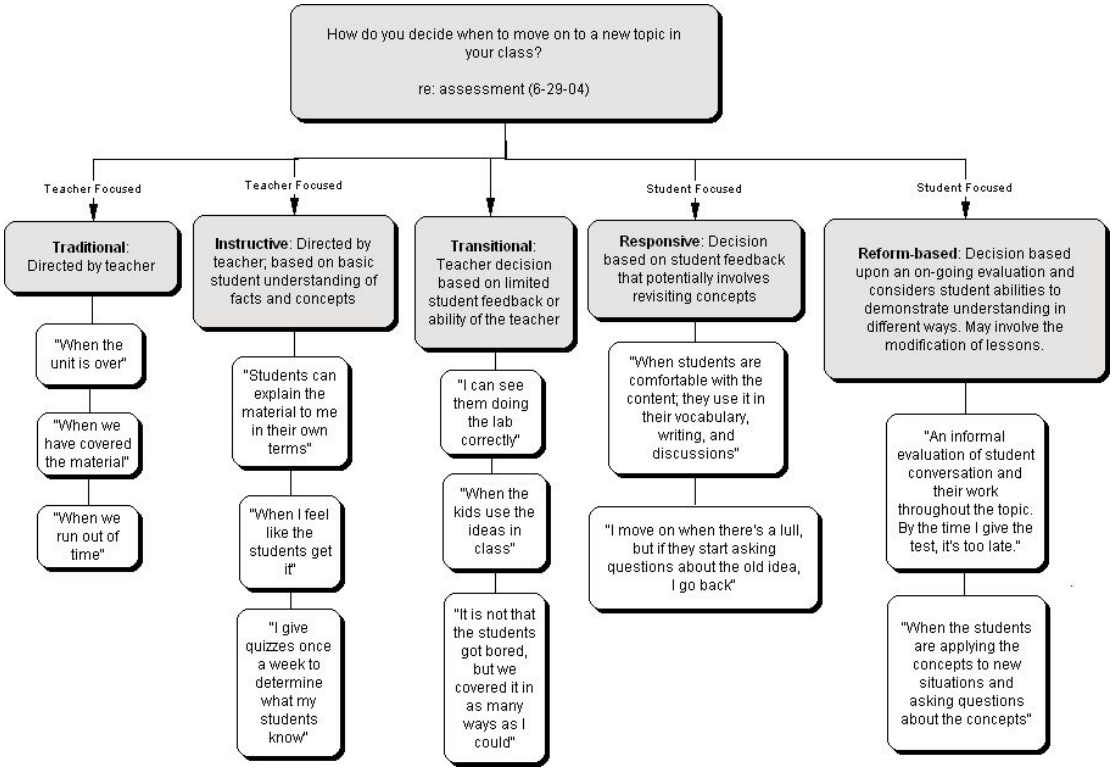
4


How do you describe your role as teacher?
re: student knowledge (7-11-04)
Teacher Focused
Traditional: Focus on information and structure
"All knowing sage"
"Deliverer of information"
"I need to provide consistent routines and classroom rules"
Teacher Focused
Instructive: Focus on providing experiences
"To provide materials and opportunities for students to learn"
"I maintain student focus to minimize management issues"
Transitional: Focus on teacher/student relationships or student understanding
Student
"I need to develop a good rapport with my students"
"You have got to make the students feel comfortable or they will have a difficult time learning"
Content
"To guide the students in developing conceptual understanding and critical thinking skills"
Student Focused
Responsive: Focus on collaboration between teacher and student
"To set up my classroom so that my students can take charge of their own learning"
Student Focused
Reform-based: Focus on mediating student prior knowledge and the knowledge of the discipline
"I am a tour guide who helps students make sense of their surroundings in a manner that is consistent with what is known"

5


How do you know when your students understand?
re: understanding (6-29-04)
Teacher Focused
Traditional: When they receive the information
"It is important that they hear it three times"
"We covered it in class"
"When I cover the lesson in different ways."
Teacher Focused
Instructive: When they can reiterate or demonstrate what has been presented
"When they can do well on a practical examination"
"When they can use their own words to explain a concept"
"When they can repeat the answer on a written test, and the answer is correct"
Transitional: When they give an explanation or response that is related to the presented information
Knowledge
"When they talk about the presented knowledge in new ways"
"When they can ask a basic question of a student during a presentation"
Affective
"Their faces light up"
"They get excited"
"When they are animated about the lesson outside of class"
Student Focused
Responsive: When they can utilize the presented knowledge
"When they can clearly defend their ideas using evidence and examples they experienced"
"When they can discuss new phenomena that they encounter in class"
Student Focused
Reform-based: When they can apply knowledge in a novel setting, or construct something novel that is related to the knowledge
"They can come up with questions or comments that represent an understanding of the topic. Often these questions use the knowledge in a new situation that we have not experienced in class."
"One of my students used trigonometry to solve physics problems"
"When students can question and dialogue in manner that expands their understanding. For example, they can successfully understand how a chemical reaction can be altered with the modification of element."

6


How do you decide when to move on to a new topic in your class?
re: assessment (6-29-04)
Teacher Focused
Traditional: Directed by teacher
"When the unit is over"
"When we have covered the material"
"When we run out of time"
Teacher Focused
Instructive: Directed by teacher; based on basic student understanding of facts and concepts
"Students can explain the material to me in their own terms"
"When I feel like the students get it"
"I give quizzes once a week to determine what my students know"
Transitional: Teacher decision based on limited student feedback or ability of the teacher
"I can see them doing the lab correctly"
"When the kids use the ideas in class"
"It is not that the students got bored, but we covered it in as many ways as I could"
Student Focused
Responsive: Decision based on student feedback that potentially involves revisiting concepts
"When students are comfortable with the content; they use it in their vocabulary, writing, and discussions"
"I move on when there's a lull, but if they start asking questions about the old idea, I go back"
Student Focused
Reform-based: Decision based upon an on-going evaluation and considers student abilities to demonstrate understanding in different ways. May involve the modification of lessons.
"An informal evaluation of student conversation and their work throughout the topic. By the time I give the test, it's too late."
"When the students are applying the concepts to new situations and asking questions about the concepts"

Appendix C

Pedagogical Knowledge Instrument

Please answer the questions on a separate document.

1. You are going to implement a lesson that requires the students to work together. It is important to you that students dialogue with one another in order to learn about the topic. What important decisions do you have to make regarding the set-up and enactment of this lesson?

2. Describe one summative and one formative assessment that could be used in your class. Describe how the assessments were developed and when they would be used.

3. You notice that the same students tend to answer the questions that you pose during your large group discussions. What are two different strategies that you can use increase student involvement?

PK Rubric				
	Minimal/Absent	Preliminary	Emerging	Proficient
Q1: Instructional-Planning You are going to implement a lesson or lab that requires the students to work together. It is important to you that student's dialogue with one another in order to learn about the topic. What important decisions do you have to make regarding the set-up and planning and execution of this lesson.	The teacher uses no group work or, if groups are used, does not match the group structure to the task at hand; and pays little or no attention to balancing student contributions to the discussion.	The teacher provides only one or two avenues for students to contribute to the discussion (i.e. student-student discussion, writing down answers on a worksheet, directly answering teacher questions or presenting information to the class); has a strategy for group work but does not adapt the strategy to the students or the situation; pays little attention to student strengths and	The teacher provides multiple avenues for students to contribute to the discussion (i.e. student-student discussion, writing down answers on a worksheet, directly answering teacher questions, and presenting information to the class); recognizes that formal group structure is not always successful but is unsure about how to adapt the structure; considers student strengths and anxieties when	The teacher provides multiple avenues for students to contribute to the discussion (see emerging); has a clear sense of how to adapt formal group structure to the students and the task to maximize student-student interaction; considers student strengths and anxieties when planning the lesson and lists strategies to adapt the lesson; and mentions several student-centered strategies to "reign in" students who tend to take over while encouraging more reticent students to speak.

		anxieties; and uses teacher-centered methods of forcing students to contribute (i.e. popsicle sticks, rewards, requiring every student to turn in their own paper, etc.)	planning the lesson but is unsure how to adapt the lesson to student needs; and mentions one student-centered strategy to keep kids on task.	
Q2: Instructional-Assessment When and how do you assess students during the course of a unit?	The teacher uses few assessment types and focuses on end of unit evaluation (tests, quizzes). Assessments are traditional (and focus on what the learner knows and can perform – not on how s/he applies, analyzes, synthesizes or evaluates). The needs of diverse learners are not considered in the design and the assessment strategy. Assessment information is not used to guide future	The teacher uses traditional assessments as well as a limited number of assessments that require higher order thinking skills (application, analysis, synthesis, and evaluation). Assessments focus on end-of unit evaluation. The teacher also does ONE of the following: a) uses one or two alternative assessments that are sensitive to the learning styles of some students (often in the form of an end-of-unit project). Or b) uses assessment feedback to guide future instruction.	The teacher uses both traditional and non-traditional assessments that ask students to use all levels of thinking. The needs of diverse learners are considered in the design of one or two assessment strategies. The teacher uses feedback from some assessments to guide future instruction.	The teacher uses a wide variety of assessment techniques (traditional and alternative, formal and informal, summative and formative) that require students to use higher order thinking skills often. The design and selection of assessments is dependent upon both the type of material being taught and the learning needs of the students. Feedback from assessments are used to shape future lessons.

	lessons.			
Q3: Instructional-Management You notice that the same students tend to answer the questions that you pose during your large group discussions. What are two different strategies that you can use to increase motivation and involvement of the other students?	The teacher ignores the behavior or chooses to handle the situation by confronting the student.	The teacher employs teaching/management strategies that restricts individual students to respond (i.e name sticks, rewards for individual behavior).	The teacher uses 1) teaching/management strategies that involve all students and give students multiple ways to respond (white boards, thumbs up or down, think-pair-share, etc) OR 2) a questioning strategy that involves more open-ended questions aimed at eliciting student experiences, feelings, reactions, and predictions while minimizing "right/wrong" questions	The teacher uses teaching/management strategies that involve all students and give students multiple ways to respond (white boards, thumbs up or down, think-pair-share, etc) AND 2) a questioning strategy that involves more open-ended questions aimed at eliciting student experiences, feelings, reactions, and predictions while minimizing "right/wrong" questions.
Q4: Classroom Management You have noticed that an increasing number of students are off-task during class activities. As a teacher, you have several options in terms of managing their behavior. What do you decide to do, and why	The teacher ignores behavior unless extreme enough to send to the office or punishes individual students in an ineffective manner.	The teacher has a structure in place to handle management issues – warning, detention, parent call etc. Minimal connection of planning to management (i.e. tends to have students work individually to minimize behavior issues or avoids certain activities).	The teacher has a structure in place to handle management issues – warning, detention, parent call etc. but goes beyond this – talks to student, other teachers etc. Teacher places equal emphasis on discipline structure and lesson planning.	Teacher recognizes a connection between planning and management – discusses adjustments to lesson planning to better engage students and expresses an understanding that discipline structure is secondary to instructional planning.

Appendix D

Preliminary Bioliteracy Questionnaire

Preliminary Bioliteracy Questionnaire

Please complete the following assessment to the best of your ability. Please do not refer to reference materials when answering the questions. Create a document that has the question number and your corresponding answer for each question.

1A Where is genetic information stored within a cell?

a. In DNA molecules
b. In protein molecules
c. In the overall cell structure.

1B Short Comment:
Describe how genetic information is stored and how it is used.

2A. When someone says that a gene is responsible for a particular disease or trait, they mean…

a. Only people with that gene get the disease or trait.
b. There are versions of the gene, called alleles, that produce the disease or trait.
c. everyone has the gene, but only some get the disease or trait and that this is determined by chance.

2B. Short Comment:
Do different people have different genes?

---

3. The number of chromosomes you have is …

a. much greater than the number of genes
b. much smaller than the number of genes
c. equal to the number of genes

3B Short Comment:
Describe where genes are located and how they are organized within a cell.

---

4. Which is the most common – a mutation will generate…

a. a new gene
b. a new allele of pre-existing gene
c. a completely new organism

4B Short comment
What is a mutation?

5A. Although mutations occur randomly, the information within a population can increase because…

a. some mutations are beneficial to the organism carrying them.

b. mutations that are beneficial can enhance the chances that organisms carrying them will reproduce more efficiently than those that don't have the mutation.

c. The presence of a mutation will kill the organism that contains it, so only health organisms will survive and reproduce.

5B Short comment
If there were no mutations, would evolution occur?

6A. If you move a gene from an organism to an organisms of another species, through the process of genetic engineering, what happens.

a. The product normally encoded by the gene will be made and can alter the behavior of the organism.

b. The gene will act in a completely new way, and a completely new type of organism will be produced

c. The gene will not be active because two biological species are so completely different that genes from one will not work in another.

6B. Short comment
Explain how it is possible that a gene from humans can 'work' in bacteria.

7A. Proteins interact with other molecules in the cell by…

binding them to the protein molecule's surface
by attracting them at a distance

binding that molecule to

7B. Short comments.
Here is a list of the major functions of proteins within a cell. Provide a short description of what each means.

Catalytic
Structural

Motility
Regulatory

8A Organisms are divided into three kingdoms, the bacteria, the archea and the eukarya. This division is based on

differences in cell structure
differences in the genetic material used
differences in the genetic code used

8B Human beings are members of which kingdom…

bacteria
archea
eukarya

8C Short comment.

Would it be possible for a human cell to make a bacterial protein using a bacterial gene?

9A How are plants different from animals?

They use a different genetic code
They have different cellular structures, specifically plant cells have a rigid cell wall.
There was never a common ancestor between the plants and animals, they arose independently.

9B As a plant grows it increases in mass. Some of this mass comes from water. Where does the most of the rest come from.

a. Mineral in the soil
b. Gases in the air
c. Minerals dissolved in water

9C What intracellular organelle is responsible for the ability of plants to extract energy from sunlight.

a. Mitochondria
b. Nucleus
c. Cytoplasm
d. Chloroplasts

9D. Short comment
What are the waste products of photosynthesis? Which of these waste products is essential for modern animal life?

10A What makes biologists believe that modern invertebrates, like insects, worms and jellyfish, and modern vertebrates (fish, reptiles and mammals), shared a common ancestor?

a. Their common body organization
b. Their common genetic regulatory pathways
c. Their common pattern of embryonic development
d. The fact that they all need oxygen to survive

10B. Short comment
How are invertebrates different from vertebrates?

11A Short Comment
What are viruses not killed by antibiotics?

12A Consider the system of circulatory system.

What circulates through this system? _____
What does this system deliver to tissues? _____
What does it remove? _____ and _____
How are the materials removed expelled from the body? _____
What organ is responsible for moving material through the system? _____
How does this organ work? _____

12B (diagram/short answer)
Veins and arteries are part of circulatory system – how are they connected?

13A Work requires energy. Where does this energy come from?
Plants get their energy from

Light
Soil
Water

13B Animals get their energy from

Internally stored fats
Things they eat
Water

13C Even when they are not moving, biological systems do work. What kinds of work does a 'resting' biologic system do?

14A When police use a 'DNA test' to determine if a sample, such as blood, came from a particular suspect, what are they looking form…

a specific type of DNA present only in the sample and the suspect
specific DNA sequences present in both the sample and the suspect
the presence of DNA

14B. (short answer)
When scientists make a genetically modified organisms, what are they doing…

15A. We live with many types of bacteria in our gut. These bacteria…

cause disease
are generally benign
live inside our cells

15B. (short answer)
How could bacteria, living in our gut, be helpful

Appendix E

Views on the Nature of Science – version C (VNOS-C)

Instructions:

- **Please answer each of the following questions. Include relevant examples whenever possible.**
- **There are no "right" or "wrong" answers to the following questions. We are only interested in your opinion on a number of issues about science.**

1) What, in your view, is science? What makes science (or a scientific discipline such as physics, biology, etc.) different from other disciplines of inquiry (e.g., religion, philosophy)?

2) What is an experiment?

3) Does the development of scientific knowledge **require** experiments?
   - If yes, explain why. Give an example to defend your position.
   - If no, explain why. Give an example to defend your position.

4) Science textbooks often represent the atom as a central nucleus composed of protons (positively charged particles) and neutrons (neutral particles) with electrons (negatively charged particles) orbiting that nucleus.
How certain are scientists about the structure of the atom?
What specific evidence, or types of evidence, **do you think** scientists used to determine what an atom looks like?

OR

4) Science textbooks often define a species as a group of organisms that share similar characteristics and can interbreed with one another to produce fertile offspring.
How certain are scientists about their characterization of what a species is?
What specific evidence, or types of evidence, **do you think** scientists used to determine what a species is?

5) Is there a difference between a scientific theory and a scientific law? Illustrate your answer with an example.

NOS aspect	More naïve views	⇔	More informed views
Empirical NOS	Science is something that is straightforward and isn't a field of study that allows a lot of opinions, personal bias, or individual views–it is fact based. (Item #1) I believe science is different . . . because it uses concrete facts that have been proven/ are observable/ can be repeated and seen by someone else to get a right or wrong answer. (Item #1)	⇔	Much of the development of scientific knowledge depends on observation . . . [But] I think what we observe is a function of convention. I don't believe that the goal of science is (or should be) the accumulation of observable facts. Rather, I think that . . . science involves abstraction, one step of abstraction after another. (Interview, follow-up on item #1)
"The Scientific Method"	Science has a particular method of going about things, the scientific method. (Item #1) The key to the difference between science and other inquires, is that science follows a rigid set of rules. (Item #1)	⇔	When you are in sixth grade you learn that here is the scientific method and the first thing you do this, and the second thing you do that and so on so forth. That's how we may say we do science, but there is a difference between the way we say we do science and the way that we actually do science. (Interview, follow-up on item #1)
General structure and aim of experiments	An experiment is a sequence of steps performed in order to prove a proposed theory. (Item #2) Experiment is everything that involves the act of collecting data and not necessarily manipulation. (Interview, follow-up on item #2)	⇔	An experiment is a controlled way to test and manipulate the objects of interest while keeping all other factors the same . . . the results . . . will lead the scientist to believe his/her theory has or doesn't have validity. (Item #2) An experiment cannot prove a theory or a hypothesis. It just discredits or adds validity to them. (Item #2)
Role of prior expectations in experiments	You usually have some sort of idea about the outcome. But I think that to have a scientific and valid experiment you should not have any bias or ideas in advance. (Interview, follow-up on item #2)	⇔	In order to organize an experiment you need to know what is going to come out of it or it wouldn't really be a test method. I don't know how you would organize a test . . . if you don't have a general idea about what you are looking for. (Interview, follow-up on item #2)
Validity of observationally-based theories and disciplines	Science would not exist without scientific procedure which is solely based on experiments . . . The development of knowledge can only be attained through precise experiments. (Item #3)	⇔	Experiments are not always crucial . . . [For] example . . . Darwin's theory of evolution . . . cannot be directly tested experimentally. Yet, because of observed data, such as fossils and rock formations, it has become virtually the lynchpin of modern biology. (Item #3)
			(rubric continues)

NOS aspect	More naïve views	⇔	More informed views
Scientific theories Nature of	Theories are just that, one person's view or thought on what occurred. (Item #4) A theory is an untested idea, or an idea that is undergoing additional tests, Generally it hasn't been proved to the satisfaction of the scientific community. (Item #4)	⇔	In the vocabulary of a scientist the word theory is used differently than in the general population. It does not mean someone's idea that can't be proven. It is a concept that has considerable evidence behind it and has endured the attempts to disprove it. (Item #4)
Functions of	We learn scientific theories just so that scientists don't start all over from the beginning . . . they just can add to the old ideas. (Item #4)	⇔	Theories set a framework of general explanation upon which specific hypotheses are developed. Theories, even if temporary, also advance the pool of knowledge by stimulating hypotheses and research, which may support the current theory or lead to new theories. (Item #4)
Logic of testing	Many theories can't be completely tested, e.g. the theory of evolution can't be tested unless you create your own world and then live for millions of years. (Item #5)	⇔	Most theories have things we cannot observe. So, we deduce consequences from them that could be tested. This indirect evidence allows us to see if the theory is valid. (Interview, follow-up to item #5)
Difference and relationship between theories and laws	A scientific law is a theory that has been . . . proven again and again over time to be true. (Item #5) A scientific law is somewhat set in stone, proven to be true . . . A scientific theory is apt to change and be proven false at any time. (Item #5)	⇔	A scientific law describes quantitative relationships between phenomena such as universal attraction between objects. Scientific theories are made of concepts that are in accordance with common observation or go beyond and propose new explanatory models for the world. (Item #5)
Tentative NOS	Compared to philosophy and religion . . . science demands definitive answers with right & wrong answers. (Item #1) I believe that most of the time they [theories] do *not* change because they are basic theories that will only accept *alterations* [italics in original]. (Item #4) A law has been tested and cannot be changed. (Item #5)	⇔	[Science] strives to ask questions and is fueled by the desire to answer such questions and the acceptance that science is not absolute. (Item #1) Theories do change because of new data and because of changing ideas and societies' view of the world changes. (item #4) Laws like theories are tentative. (Item #5)

Appendix F

GK-12 Letter (June 2005)

University of X
College Road
Springfield, TX
June 28, 2005

Dear Dr.Smith:

During the past two years The University of Texas at Austin has participated in the NSF-GK-12 program. The program has been successful in initiating the collaboration of scientists and classroom science teachers. My doctoral supervisor, Dr. James P. Barufaldi, and I are conducting a study to determine how other NSF-GK-12 programs across the country have succeeded, and what activities have contributed to the successful aspects of their programs.

The methodology for the study involves comparing the successful aspects of each program by analyzing data gathered from final evaluation reports. It is anticipated that the results, conclusions, and recommendations generated from the study will further assist GK-12 program investigators and staff in selecting and implementing educationally and scientifically sound activities that reflect contemporary science education. Given the high level of interest in the NSF-GK-12 program, the results from the study will be presented at regional, state and national conferences to science educators, scientists, administrators and others to help inform them about the GK-12 program and other similar programs.

In order to accomplish our research agenda we ask that you share your final evaluation report(s) with us by sending a copy in the SASE provided or by email to pcc@mail.utexas.edu. All information collected from this study will be kept confidential and your program will not be identified by name. This includes presentations of the work, conferences, and articles. We would appreciate receiving the evaluations by August 3th. If you have any questions about this study at this time, please contact Peter Cormas at (512) 232-6170 or by email at pcc@mail.utexas.edu.

We sincerely hope you will participate in the study. Your contribution will be greatly appreciated.

Sincerely,

Peter Cormas, M.S.
NSF-GK-12 Research Assistant

James P. Barufaldi, Ph.D.
Ruben E, Hinojosa Regents Professor
Distinguished Teaching Professor
Director, Center for Science and Mathematics Education

Appendix G

GK-12 Email (December 2005)

Dear Dr. Smith:

We are still very interested in the GK-12 evaluation for University of X. We have nearly every evaluation in the country with the exception of your institution's and a few others. If you have questions about the study, please call me on my cell phone at (512) 517-0215 or email me. I have also attached the letter that was initially sent to all sites.

Thank you,

Peter C. Cormas, M.S.
GK-12 Graduate Research Assistant
Doctoral Candidate, Science Education

The University of Texas at Austin
1 University Station D5705
Austin, TX 78712
Phone: (512)232-6170 | Fax: (512)471-8466

Appendix H

Expert Interview Email

Dear Dr. Smith

I would like to invite you to participate in a study that I am confident will be of interest to you. As part of my doctoral research at The University of Texas at Austin, I have compiled a comprehensive list of texts that describe effective characteristics of professional development for teachers. These lists were created by researchers, research groups, and other educational organizations. Two rigorous content analyses with multiple reliability tests were performed in order to reduce these lists to the most effective research-based characteristics of professional development. As an expert in your field, I seek your ideas and thoughts concerning these characteristics.

If you decide to participate, I will phone you and ask you three semi-structured interview questions. The questions that I will ask are:

1) You have looked over the list of effective characteristics of professional development. Do you agree or disagree with this list, and why?
2) Do you see any characteristics that should or should not be on the list?
3) Do you have any additional comments pertaining to the list or the study?

The last two questions may not be necessary depending on your response to the first question. Also, I may ask you additional questions based on your responses so that I fully understand your ideas.

Sincerely,
Peter C. Cormas, M.S.

Effective Research-Based Characteristics of Professional Development

1. Teachers' discipline-specific knowledge is increased
2. Teachers understand how students learn and what are effective teaching strategies within a specific discipline
3. Teachers understand how students learn and what are effective teaching strategies
4. Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked
5. Requires resources (money and time)
6. Professional development is on-going
7. Professional development occurs in day-to-day contexts of teachers
8. Uses effective teaching strategies
9. Coherent/aligned with school/district/state goals
10. Teachers provide input into professional development design; professional development is engaging and relevant
11. Involves collaboration between teachers and others
12. Generates further collaboration or projects
13. Treats teachers as professionals
14. Promotes teacher self-reflection

15. Uses inquiry as a teaching style
16. Increases teacher ability to meet needs of diverse learners

Peter C. Cormas, M.S.
GK-12 Graduate Research Assistant
Doctoral Candidate, Science Education

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Appendix I

Draft-Coding Sheets

Table 4.2: ERBCPD Draft Coding Sheet: Rater 1

	Characteristics	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18
a	Increases content knowledge	P	A	P	P	P	A	P	P	P	A	P	A	P	P	A	P	P
b	Increases PCK	P	A	A	P	P	A	A	A	A	P	P	A	A	A	A	P	A
c	Increases pedagogical knowledge	P	A	P	P	P	P	P	P	P	A	A	A	P	P	P	P	P
d	Design is based on research	P	P	P	A	A	A	P	P	A	A	A	P	P	A	P	A	P
e	Evaluation is based on data	P	A	P	P	P	P	P	P	A	A	A	P	P	A	A	P	P
f	Requires resources ($ and time)	A	A	P	A	A	A	A	P	A	A	A	P	P	A	A	P	P
g	Sustained and intensive	A	P	A	P	P	A	A	A	P	P	A	A	P	P	P	P	P
h	Localized/site-based/embedded	A	P	P	P	P	A	A	A	A	A	A	A	A	P	A	P	P
i	Models good teaching	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
j	Coherent/aligned with school/district/state goals	P	P	P	P	P	A	P	P	P	P	P	P	P	A	P	P	P
k	Aligned with teacher needs	P	P	A	P	P	P	P	P	P	A	P	A	P	A	P	P	P
l	Involves collaboration between teachers and others	A	P	P	P	P	A	P	P	P	A	A	P	P	P	P	P	P
m	Generates further collaboration or projects	A	A	P	P	P	A	P	P	A	A	A	P	A	A	A	A	P
n	Respects teachers	P	P	P	P	P	A	P	P	A	A	P	P	P	P	A	A	P
o	Promotes teacher self-reflection	A	A	P	P	A	A	A	A	A	A	A	A	P	A	P	A	A
p	Uses inquiry as a teaching style	A	A	A	A	A	A	A	A	A	P	P	A	P	A	P	A	A
q	Increases teacher ability to meet needs of diverse learners	A	A	A	A	A	P	A	P	A	A	A	A	A	A	A	A	P

Table 4.3: ERBCPD Draft Coding Sheet: Rater 2

	Characteristics	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18
a	Increases content knowledge	P	A	P	P	A	A	P	P	P	A	P	P	P	P	P	P	P
b	Increases PCK	P	A	A	P	P	A	A	A	A	P	P	P	P	A	A	A	A
c	Increases pedagogical knowledge	P	P	P	P	P	P	P	P	A	A	P	P	P	P	P	P	P
d	Design is based on research	P	A	P	A	A	A	P	P	A	A	A	A	A	A	P	A	P
e	Evaluation is based on data	P	A	P	P	P	A	P	P	A	A	A	A	P	A	A	P	P
f	Requires resources ($ and time)	A	P	P	P	P	A	A	P	P	A	A	A	P	A	A	A	P
g	Sustained and intensive	A	P	A	A	P	A	A	A	A	P	A	A	P	P	P	P	P
h	Localized/site-based/embedded	A	P	P	P	P	A	A	A	A	A	A	A	A	P	A	P	P
i	Models good teaching	A	P	A	P	A	A	P	P	A	A	A	A	A	A	A	A	A
j	Coherent/aligned with school/district/state goals	P	P	P	P	P	A	A	P	P	P	P	P	P	A	A	A	P
k	Aligned with teacher needs	P	P	P	P	P	P	P	A	P	A	A	A	P	P	P	P	P
l	Involves collaboration between teachers and others	A	A	P	P	P	A	P	P	P	A	A	A	P	A	P	P	P
m	Generates further collaboration or projects	A	A	A	P	A	A	P	P	A	A	A	A	A	P	A	A	A
n	Respects teachers	A	P	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A
o	Promotes teacher self-reflection	A	A	A	P	A	A	P	A	A	A	A	A	P	A	A	A	P
p	Uses inquiry as a teaching style	A	A	P	P	A	A	A	A	A	A	A	A	P	P	P	A	A
q	Increases teacher ability to meet needs of diverse learners	A	A	A	A	A	P	A	P	A	A	A	A	A	A	A	A	P

Table 4.4: ERBCPD Draft Coding Sheet, Inter-rater Reliability: Rater 1

	Characteristics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**14**	**15**	**16**	**17**	**18**	**K**
a	Increases content knowledge	P	A	P	A	P	A	P	P	P	A	P	A	P	P	A	P	P	0.87
b	Increases PCK	P	A	A	P	A	A	A	A	A	P	P	A	A	A	A	P	A	0.87
c	Increases pedagogical knowledge	P	A	P	P	P	A	P	P	P	A	A	A	P	P	P	P	P	0.85
d	Design is based on research	A	P	P	A	A	A	P	P	A	A	A	P	P	A	P	A	P	0.88
e	Evaluation is based on data	P	A	P	P	P	P	P	P	P	A	A	P	P	A	A	P	P	0.87
f	Requires resources ($ and time)	A	A	P	A	A	A	A	P	A	A	P	P	P	A	A	P	P	0.88
g	Sustained and intensive	A	P	A	A	P	A	A	A	P	P	A	A	P	P	P	P	P	0.88
h	Localized/site-based/embedded	A	P	P	P	P	A	A	A	A	A	A	A	A	P	A	P	P	1
i	Models good teaching	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	1
j	Coherent/aligned with school/district/state goals	P	P	A	P	P	A	P	P	P	P	P	P	P	A	P	P	P	0.82
k	Aligned with teacher needs	P	P	A	P	P	P	P	P	P	A	P	A	P	A	P	P	P	1
l	Involves collaboration between teachers and others	A	P	P	A	P	A	P	P	P	A	A	P	P	P	P	P	P	0.87
m	Generates further collaboration or projects	A	A	P	P	P	A	P	P	A	A	A	P	A	P	A	A	P	1
n	Respects teachers	P	P	P	P	P	A	P	P	A	A	P	P	P	P	A	A	P	0.86
o	Promotes teacher self-reflection	A	A	P	P	A	A	A	p	A	A	A	A	P	A	P	A	A	0.85
p	Uses inquiry as a teaching style	A	A	A	A	A	A	A	A	A	P	P	A	P	A	P	A	A	1
q	Increases teacher ability to meet needs of diverse learners	A	A	A	A	A	P	A	P	A	A	A	A	A	A	A	A	P	1

Table 4.5: ERBCPD Draft Coding Sheet, Inter-rater Reliability Differences: Rater 1

	Characteristics	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18
a	Increases content knowledge				*													
b	Increases PCK					*												
c	Increases pedagogical knowledge						*											
d	Design is based on research	*																
e	Evaluation is based on data									*								
f	Requires resources ($ and time)											*						
g	Sustained and intensive				*													
h	Localized/site-based/embedded																	
i	Models good teaching																	
j	Coherent/aligned with school/district/state goals			*														
k	Aligned with teacher needs																	
l	Involves collaboration between teachers and others				*													
m	Generates further collaboration or projects																	
n	Respects teachers														*			
o	Promotes teacher self-reflection								*									
p	Uses inquiry as a teaching style																	
q	Increases teacher ability to meet needs of diverse learners																	

Table 4.6: ERBCPD Draft Coding Sheet, Inter-rater Reliability: Rater 2

	Characteristics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**14**	**15**	**16**	**17**	**18**	**K**
a	Increases content knowledge	P	A	P	P	P	A	P	P	P	A	P	P	P	P	P	P	P	0.82
b	Increases PCK	P	A	A	P	P	A	A	A	A	P	P	P	P	A	A	A	A	1
c	Increases pedagogical knowledge	P	P	P	P	P	P	P	P	A	A	P	P	P	P	P	P	P	1
d	Design is based on research	P	A	P	A	A	A	P	P	A	A	A	A	A	A	A	A	P	0.87
e	Evaluation is based on data	P	A	P	P	P	A	P	P	A	A	A	A	P	A	A	P	P	1
f	Requires resources ($ and time)	A	P	P	P	P	A	A	P	A	A	A	A	P	A	A	A	P	0.88
g	Sustained and intensive	A	P	A	A	P	A	A	A	A	P	A	A	P	P	P	P	P	1
h	Localized/site-based/embedded	A	P	P	P	P	A	A	A	A	A	A	A	A	P	A	P	P	1
i	Models good teaching	P	P	A	P	A	A	P	P	A	A	A	A	A	A	A	A	A	0.85
j	Coherent/aligned with school/district/state goals	P	P	P	P	P	A	A	P	P	P	P	P	P	A	A	A	P	1
k	Aligned with teacher needs	P	P	A	P	P	P	P	A	P	A	A	A	P	P	P	P	P	0.85
l	Involves collaboration between teachers and others	A	A	P	P	P	A	P	P	P	A	A	A	P	P	P	P	P	0.88
m	Generates further collaboration or projects	A	A	A	P	A	A	P	P	A	A	A	A	A	P	A	A	A	1
n	Respects teachers	A	P	P	P	A	P	A	A	A	A	A	A	A	A	A	A	A	0.82
o	Promotes teacher self-reflection	A	A	A	P	A	A	P	A	A	A	A	A	P	A	A	A	P	1
p	Uses inquiry as a teaching style	A	A	P	P	A	A	A	A	A	A	A	A	P	P	P	A	A	1
q	Increases teacher ability to meet needs of diverse learners	A	A	A	A	A	P	A	P	A	A	A	A	A	A	A	A	P	1

Table 4.7: ERBCPD Draft Coding Sheet, Inter-rater Reliability Differences: Rater 2

	Characteristics	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18
a	Increases content knowledge					*												
b	Increases PCK																	
c	Increases pedagogical knowledge																	
d	Design is based on research															*		
e	Evaluation is based on data																	
f	Requires resources ($ and time)									*								
g	Sustained and intensive																	
h	Localized/site-based/embedded																	
i	Models good teaching	*																
j	Coherent/aligned with school/district/state goals																	
k	Aligned with teacher needs			*														
l	Involves collaboration between teachers and others														*			
m	Generates further collaboration or projects																	
n	Respects teachers						*											
o	Promotes teacher self-reflection																	
p	Uses inquiry as a teaching style																	
q	Increases teacher ability to meet needs of diverse learners																	

Table 4.8: ERBCPD Draft-Coding Sheet Reliability Changes, Raters 1 and 2

	Characteristics	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18	K
a	Increases content knowledge					N										N			0.72
b	Increases PCK													N			N		0.74
c	Increases pedagogical knowledge		P							A		P							1
d	Design is based on research		N		N								N	P					~~0.66~~
e	Evaluation is based on data						N												0.88
f	Requires resources ($ and time)		P		P	P				P			P				P		1.0
g	Sustained and intensive				N					N							N		0.77
h	Localized/site-based/embedded																		1
i	Models good teaching				P			P	P				A						1
j	Coherent/aligned with school/district/state goals							P								P			0.77
k	Aligned with teacher needs			P					A			A			N				0.85
l	Involves collaboration between teachers and others		N												N				0.72
m	Generates further collaboration or projects	P		A		P									A			N	0.74
n	Respects teachers	N				P		P	A			A		P	P			P	0.88
o	Promotes teacher self-reflection			A				P								P		P	1
p	Uses inquiry as a teaching style			A	P							P			A				0.85
q	Increases teacher ability to meet needs of diverse learners																		1

Table 4.10: ERBCPD Draft Coding Sheet: Rater 3

	Characteristics	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18
a	Teachers' discipline-specific knowledge is increased	P	A	P	P	A	A	P	P	P	A	P	A	P	P	A	A	P
b	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.	P	A	A	P	P	A	A	A	A	P	P	A	A	A	A	A	A
c	Teachers understand how students learn and what are effective teaching strategies.	P	P	P	P	P	A	P	P	A	A	P	A	A	P	P	P	P
d	Design is based on research	P	A	P	A	P	A	P	P	A	A	A	A	P	A	P	A	P
e	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.	P	A	P	P	P	A	P	P	A	A	A	A	P	A	A	A	P
f	Requires resources (money and time)	A	P	P	A	A	A	A	P	A	A	A	A	P	A	A	A	A
g	Professional development is on-going	A	A	P	P	P	A	A	A	A	A	P	A	P	P	P	P	P
h	Professional development occurs in day-to-day contexts of teachers	A	A	P	P	P	A	A	A	A	A	A	A	P	P	P	P	P
i	Uses effective teaching strategies	A	P	A	P	A	A	A	P	P	A	A	A	P	A	A	P	A
j	Coherent/aligned with school/district/state goals	P	A	A	A	A	A	A	P	A	A	A	P	A	A	A	A	P
k	Teachers provide input into professional development design; professional development is engaging and relevant	P	A	A	P	P	A	A	A	A	A	A	A	A	A	A	A	P
l	Involves collaboration between teachers and others	A	P	P	P	P	A	P	A	A	A	P	P	P	P	P	P	P
m	Generates further collaboration or projects	A	P	A	P	A	A	A	A	A	A	A	P	A	A	A	A	P
n	Treats teachers as professionals	A	P	A	A	A	A	A	A	A	A	A	P	A	A	A	A	P
o	Promotes teacher self-reflection	A	A	A	P	A	A	A	A	A	A	A	A	P	P	A	A	P
p	Uses inquiry as a teaching style	A	A	P	P	A	P	A	A	A	P	P	A	P	A	A	A	P
q	Increases teacher ability to meet needs of diverse learners	A	A	A	A	A	P	A	P	A	A	A	A	A	A	A	A	P

Table 4.11: ERBCPD Draft Coding Sheet: Rater 4

	Characteristics	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18
a	Teachers' discipline-specific knowledge is increased	P	A	P	P	A	A	P	P	P	A	A	A	A	P	A	A	P
b	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.	P	A	A	P	P	A	A	A	A	P	P	A	A	A	A	A	A
c	Teachers understand how students learn and what are effective teaching strategies.	P	P	P	P	A	A	P	P	A	A	A	A	P	P	A	P	P
d	Design is based on research	P	A	P	A	P	A	P	P	A	A	A	A	A	A	P	P	P
e	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.	P	A	P	P	P	A	P	P	A	A	A	A	P	A	A	P	P
f	Requires resources (money and time)	A	P	P	A	A	A	A	P	A	P	A	A	P	A	A	A	P
g	Professional development is on-going	A	P	P	P	P	A	A	A	A	A	A	A	P	P	P	P	P
h	Professional development occurs in day-to-day contexts of teachers	A	P	A	A	P	A	A	A	A	A	A	A	P	P	P	A	P
i	Uses effective teaching strategies	A	P	P	A	A	P	A	A	A	A	A	A	A	A	A	A	A
j	Coherent/aligned with school/district/state goals	P	P	A	A	A	A	A	P	A	A	A	P	A	A	A	P	P
k	Teachers provide input into professional development design; professional development is engaging and relevant	P	P	P	A	A	P	P	A	P	A	A	P	P	A	P	P	P
l	Involves collaboration between teachers and others	A	P	P	P	P	A	P	P	P	A	A	P	P	P	P	P	P
m	Generates further collaboration or projects	A	P	P	A	A	A	A	A	A	A	P	P	P	P	A	A	A
n	Treats teachers as professionals	A	P	P	P	P	A	P	A	A	A	A	P	A	A	A	A	P
o	Promotes teacher self-reflection	P	P	P	P	A	A	A	A	A	A	P	A	P	P	P	A	P
p	Uses inquiry as a teaching style	A	P	A	A	A	P	A	A	A	P	P	A	P	A	A	A	P
q	Increases teacher ability to meet needs of diverse learners	A	A	A	A	A	P	A	P	A	A	A	A	A	A	A	A	P

Table 4.12: ERBCPD Draft Coding Sheet, Inter-rater Reliability: Rater 3

	Characteristics	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18	K
a	Teachers' discipline-specific knowledge is increased	P	A	P	P	A	A	P	P	P	A	P	A	P	P	A	A	P	1
b	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.	P	A	A	P	P	A	A	A	A	A	P	A	A	A	A	A	A	0.85
c	Teachers understand how students learn and what are effective teaching strategies.	P	P	P	P	P	A	P	P	A	A	P	A	A	P	P	P	P	1
d	Design is based on research	P	A	P	A	P	A	P	A	A	A	A	A	P	A	P	A	P	1
e	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.	P	A	P	P	P	A	P	P	A	A	A	A	P	A	A	A	A	0.88
f	Requires resources (money and time)	A	P	P	A	A	A	A	P	A	A	A	A	P	A	A	A	A	1
g	Professional development is on-going	A	A	P	P	P	A	A	A	A	A	P	A	P	P	P	P	P	1
h	Professional development occurs in day-to-day contexts of teachers	P	A	P	P	P	A	A	A	A	A	A	A	P	P	P	P	P	0.88
i	Uses effective teaching strategies	A	P	P	P	A	A	A	P	P	A	A	A	P	A	A	P	A	0.88
j	Coherent/aligned with school/district/state goals	P	A	P	A	A	A	A	P	A	A	A	P	A	A	A	A	P	0.85
k	Teachers provide input into professional development design; professional development is engaging and relevant	P	A	A	P	P	A	A	A	A	A	A	A	A	A	A	A	P	1
l	Involves collaboration between teachers and others	A	P	P	P	P	A	P	A	A	A	P	P	P	P	P	P	P	1
m	Generates further collaboration or projects	A	P	A	P	A	A	P	A	A	A	A	P	A	A	A	A	P	0.85
n	Treats teachers as professionals	A	P	A	A	A	A	A	A	A	A	A	P	A	A	A	A	P	1
o	Promotes teacher self-reflection	A	A	A	P	A	A	A	A	P	A	A	A	P	P	A	A	P	0.85
p	Uses inquiry as a teaching style	A	A	P	P	A	P	A	A	A	P	P	A	P	A	A	A	P	1
q	Increases teacher ability to meet needs of diverse learners	A	A	P	A	A	P	A	P	A	A	A	A	A	A	A	A	P	0.82

Table 4.13: ERBCPD Draft Coding Sheet, Inter-rater Reliability Differences: Rater 3

	Characteristics	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18
a	Teachers' discipline-specific knowledge is increased																	
b	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.										*							
c	Teachers understand how students learn and what are effective teaching strategies.																	
d	Design is based on research								*									
e	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.																	*
f	Requires resources (money and time)																	
g	Professional development is on-going																	
h	Professional development occurs in day-to-day contexts of teachers	*																
i	Uses effective teaching strategies			*														
j	Coherent/aligned with school/district/state goals			*														
k	Teachers provide input into professional development design; professional development is engaging and relevant																	
l	Involves collaboration between teachers and others																	
m	Generates further collaboration or projects							*										
n	Treats teachers as professionals																	
o	Promotes teacher self-reflection									*								
p	Uses inquiry as a teaching style																	
q	Increases teacher ability to meet needs of diverse learners			*														

Table 4.14: ERBCPD Draft Coding Sheet, Inter-rater Reliability: Rater 4

	Characteristics	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18	K
a	Teachers' discipline-specific knowledge is increased	P	A	P	P	A	A	P	P	P	A	A	A	A	P	A	A	P	1
b	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.	P	A	A	P	P	A	A	A	A	P	P	A	A	A	A	A	A	1
c	Teachers understand how students learn and what are effective teaching strategies.	P	P	P	P	A	A	A	P	A	A	A	A	P	P	A	P	P	0.88
d	Design is based on research	P	A	P	A	P	A	P	P	A	A	A	A	A	A	P	P	P	1
e	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.	P	A	A	P	P	A	P	P	A	A	A	A	P	A	A	P	P	0.88
f	Requires resources (money and time)	A	P	P	P	A	A	A	P	A	P	A	A	P	A	A	A	P	0.88
g	Professional development is on-going	A	P	P	P	P	A	A	A	A	A	A	A	P	P	P	P	P	1
h	Professional development occurs in day-to-day contexts of teachers	A	P	A	A	P	A	A	A	A	A	A	A	P	P	P	A	P	1
i	Uses effective teaching strategies	A	P	P	A	A	P	A	A	A	A	A	A	A	A	A	A	A	1
j	Coherent/aligned with school/district/state goals	P	P	A	A	A	A	A	P	A	A	A	P	A	A	A	P	P	1
k	Teachers provide input into professional development design; professional development is engaging and relevant	P	P	P	A	A	P	P	A	P	A	A	P	P	A	P	P	P	1
l	Involves collaboration between teachers and others	A	P	P	A	P	A	P	P	P	A	A	P	P	P	P	P	P	0.87
m	Generates further collaboration or projects	A	P	P	A	A	A	A	A	A	A	P	P	P	P	A	A	A	1
n	Treats teachers as professionals	A	P	P	P	P	A	P	A	A	A	A	P	A	P	A	A	P	0.88
o	Promotes teacher self-reflection	P	P	P	P	A	A	A	A	A	A	P	A	P	P	P	A	A	0.88
p	Uses inquiry as a teaching style	A	P	A	A	A	P	A	A	A	P	P	A	P	A	A	A	P	1
q	Increases teacher ability to meet needs of diverse learners	A	A	A	A	A	P	A	P	A	A	A	A	A	A	A	A	P	1

Table 4.15: ERBCPD Draft Coding Sheet, Inter-rater Reliability Differences: Rater 4

	Characteristics	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18
a	Teachers' discipline-specific knowledge is increased																	
b	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.																	
c	Teachers understand how students learn and what are effective teaching strategies.							*										
d	Design is based on research																	
e	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.			*														
f	Requires resources (money and time)				*													
g	Professional development is on-going																	
h	Professional development occurs in day-to-day contexts of teachers																	
i	Uses effective teaching strategies																	
j	Coherent/aligned with school/district/state goals																	
k	Teachers provide input into professional development design; professional development is engaging and relevant																	
l	Involves collaboration between teachers and others				*													
m	Generates further collaboration or projects																	
n	Treats teachers as professionals														*			
o	Promotes teacher self-reflection																	*
p	Uses inquiry as a teaching style																	
q	Increases teacher ability to meet needs of diverse learners																	

Table 4.16: ERBCPD Draft-Coding Sheet Reliability Changes, Raters 3 and 4

	Characteristics	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18	K
a	Teachers' discipline-specific knowledge is increased											A		P					1
b	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.																		1
c	Teachers understand how students learn and what are effective teaching strategies.					A						A		P		P			1
d	Design is based on research													P		A			1
e	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.															P			1
f	Requires resources (money and time)										P						P		1
g	Professional development is on-going		P								A	A							1
h	Professional development occurs in day-to-day contexts of teachers		A	P	P												P		1
i	Uses effective teaching strategies			P	P		A		P	A				A			A		1
j	Coherent/aligned with school/district/state goals		P														P		1
k	Teachers provide input into professional development design; professional development is engaging and relevant		A	A	A	P	A	A		P			A	P		P	P		1
l	Involves collaboration between teachers and others								P	P		A							1
m	Generates further collaboration or projects			A	A							A		A	A			A	1
n	Treats teachers as professionals			P	P	A		P											1
o	Promotes teacher self-reflection	A	A	A								A				A			1
p	Uses inquiry as a teaching style		P		P														1
q	Increases teacher ability to meet needs of diverse learners																		1

Table 4.17: ERBCPD Draft-Coding Sheet Results, Raters 3 and 4

	Characteristics	K before discussion	K after discussion
a	Teachers' discipline-specific knowledge is increased	0.77	1
b	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.	1	1
c	Teachers understand how students learn and what are effective teaching strategies.	0.49	1
d	Design is based on research	0.76	1
e	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.	0.88	1
f	Requires resources (money and time)	0.72	1
g	Professional development is on-going	0.64	1
h	Professional development occurs in day-to-day contexts of teachers	0.52	1
i	Uses effective teaching strategies	-0.02	1
j	Coherent/aligned with school/district/state goals	0.55	1
k	Teachers provide input into professional development design; professional development is engaging and relevant	-0.08	1
l	Involves collaboration between teachers and others	0.55	1
m	Generates further collaboration or projects	0.16	1
n	Treats teachers as professionals	0.04	1
o	Promotes teacher self-reflection	0.27	1
p	Uses inquiry as a teaching style	0.63	1
q	Increases teacher ability to meet needs of diverse learners	1	1

Table 4.22: GK-12 Draft Coding Sheet: Rater 5 (Failed)

	Characteristics	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u
1	Teachers' discipline-specific knowledge is increased	A	A	P	P	P	A	P	A	A	P	A	A	P	A	P	A	A	P	A	P	P
2	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.	A	A	A	P	P	A	A	A	A	P	P	A	P	P	P	A	A	P	P	P	P
3	Teachers understand how students learn and what are effective teaching strategies.	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
4	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.	A	A	A	A	P	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A
5	Requires resources (money and time)	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
6	Professional development is on-going	A	P	P	P	P	P	P	P	A	P	A	A	P	P	P	P	A	P	P	P	P
7	Professional development occurs in day-to-day contexts of teachers	A	A	P	P	A	A	P	A	A	P	A	A	P	P	P	A	A	P	P	P	P
8	Uses effective teaching strategies	P	A	A	P	A	A	A	A	A	P	P	P	P	P	P	P	A	P	P	P	P
9	Coherent/aligned with school/district/state goals	A	A	A	A	P	A	A	A	A	P	P	A	A	A	A	A	A	A	A	A	A
10	Teachers provide input into professional development design; professional development is engaging and relevant	A	P	P	P	A	A	A	A	A	P	A	A	P	A	A	A	A	A	P	A	P
11	Involves collaboration between teachers and others	P	P	P	P	P	P	P	P	A	P	P	P	P	P	P	P	P	P	P	P	P
12	Generates further collaboration or projects	A	A	P	A	P	A	A	A	A	A	P	A	A	P	P	A	A	P	A	P	P
13	Treats teachers as professionals	A	P	A	P	P	A	A	P	A	P	P	A	A	P	P	A	A	P	A	P	P
14	Promotes teacher self-reflection	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
15	Uses inquiry as a teaching style	A	A	P	P	P	A	P	A	A	P	P	A	P	P	P	P	A	P	P	P	P
16	Increases teacher ability to meet needs of diverse learners	A	A	A	P	P	A	A	A	A	A	A	A	A	P	P	A	A	A	A	A	P
17	Teachers provide an opportunity for real world applications	A	A	A	P	P	A	A	A	A	P	A	P	A	P	A	P	A	A	A	A	A
18	Improved communication skills	P	P	P	A	P	P	A	P	A	P	A	A	A	A	A	A	A	P	P	A	P

Table 4.23: GK-12 Draft Coding Sheet: Rater 6 (Failed)

	Characteristics	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u
1	Teachers' discipline-specific knowledge is increased	A	A	P	A	P	A	A	A	A	P	A	A	P	A	A	A	A	A	A	P	P
2	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
3	Teachers understand how students learn and what are effective teaching strategies.	A	A	A	A	A	P	A	A	A	A	P	A	P	A	A	A	A	A	A	P	A
4	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.	P	A	A	A	P	A	A	A	P	A	P	A	A	P	P	A	A	A	P	P	A
5	Requires resources (money and time)	P	P	P	P	P	P	A	P	A	P	P	A	P	P	P	A	A	P	P	P	P
6	Professional development is on-going	A	A	P	A	P	P	A	A	A	P	P	A	P	P	A	A	A	P	A	A	P
7	Professional development occurs in day-to-day contexts of teachers	A	A	P	P	A	P	A	A	A	P	A	A	P	A	A	A	A	P	A	A	P
8	Uses effective teaching strategies	A	A	A	A	A	A	A	A	A	P	P	A	P	P	A	A	A	A	A	A	P
9	Coherent/aligned with school/district/state goals	A	A	P	A	P	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A
10	Teachers provide input into professional development design; professional development is engaging and relevant	A	A	P	A	A	A	A	P	A	P	A	A	P	A	A	A	A	A	P	A	A
11	Involves collaboration between teachers and others	A	P	P	P	P	P	A	P	A	P	P	P	P	P	P	P	A	P	P	P	P
12	Generates further collaboration or projects	A	A	P	P	P	A	A	P	A	P	A	A	P	P	A	P	A	A	A	A	A
13	Treats teachers as professionals	A	A	P	A	P	A	A	P	A	P	P	A	P	P	P	A	A	P	P	P	P
14	Promotes teacher self-reflection	A	A	A	A	A	A	A	A	A	A	A	A	P	A	P	A	A	A	A	A	A
15	Uses inquiry as a teaching style	A	A	P	A	A	A	A	A	A	P	P	A	P	P	P	A	A	P	A	A	A
16	Increases teacher ability to meet needs of diverse learners	A	A	A	A	A	P	A	A	A	A	A	A	P	A	A	A	A	P	A	A	A
17	Teachers provide an opportunity for real world applications	A	A	P	P	P	A	A	A	A	P	A	P	A	A	A	P	A	A	A	A	A
18	Improved communication skills	P	A	P	A	P	P	P	P	A	P	A	A	A	A	A	A	A	P	P	A	A

Table 4.24: GK-12 Draft Coding Sheet, Reliability Changes, Raters 3 and 4 (Failed)

	Characteristics	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u
1	Teachers' discipline-specific knowledge is increased				N			P								A			P			
2	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.				N	P					N	A		A	N	A			N	A	P	N
3	Teachers understand how students learn and what are effective teaching strategies.						P					P		P							P	
4	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.	N								N		N			N					A	N	
5	Requires resources (money and time)							P		N			P			P	P					
6	Professional development is on-going		N		N			A	P			P				N	N			P	A	
7	Professional development occurs in day-to-day contexts of teachers		P				P	A							A	A				P	P	
8	Uses effective teaching strategies	N			N								A			A	A		N	A	P	
9	Coherent/aligned with school/district/state goals			A							P											
10	Teachers provide input into professional development design; professional development is engaging and relevant		A		A				P													A
11	Involves collaboration between teachers and others	A						A										P				
12	Generates further collaboration or projects				P				P		A	P		N		P	P		N		A	P
13	Treats teachers as professionals		N	P	P									P						P		
14	Promotes teacher self-reflection													P		N						
15	Uses inquiry as a teaching style				A	A		A									A			A	A	A
16	Increases teacher ability to meet needs of diverse learners				N	N	P							A	N	N			A			N
17	Teacher provide an opportunity for real world application			N											N							
18	Improved communication skills		P					N														N

Table 4.26: GK-12 Draft Coding Sheet: Rater 5

	Characteristics	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u
1	Teachers' discipline-specific knowledge is increased	A	A	P	P	P	A	P	A	A	P	A	A	P	A	P	A	A	P	P	P	P
2	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.	A	A	A	P	P	A	A	A	A	P	P	A	A	P	A	A	A	A	P	P	A
3	Teachers understand how students learn and what are effective teaching strategies.	A	A	P	A	A	P	A	A	A	A	P	A	P	A	A	A	A	P	P	P	P
4	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.	A	A	A	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
5	Requires resources (money and time)	P	P	P	P	P	P	P	P	A	P	P	P	P	P	P	P	P	P	P	P	P
6	Professional development is on-going	A	A	P	P	P	A	A	P	A	P	P	A	P	A	P	P	A	P	P	P	P
7	Professional development occurs in day-to-day contexts of teachers	A	A	P	P	P	P	P	A	A	P	A	P	P	P	P	A	A	P	P	P	P
8	Uses effective teaching strategies	A	A	A	A	A	P	A	A	A	A	P	A	P	A	A	A	A	P	P	P	A
9	Coherent/aligned with school/district/state goals	P	A	A	P	P	A	A	A	P	P	P	A	A	A	A	A	P	A	A	A	A
10	Teachers provide input into professional development design; professional development is engaging and relevant	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
11	Involves collaboration between teachers and others	P	A	P	P	P	A	P	P	A	P	A	A	P	A	P	A	A	P	P	P	P
12	Generates further collaboration or projects	A	A	P	P	P	A	A	A	A	A	P	A	A	A	A	A	A	P	A	A	P
13	Treats teachers as professionals	A	A	P	P	P	A	P	P	A	P	A	A	P	A	A	A	A	P	P	P	P
14	Promotes teacher self-reflection	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
15	Uses inquiry as a teaching style	A	A	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	P	A
16	Increases teacher ability to meet needs of diverse learners	A	A	A	A	A	P	P	A	A	A	A	A	A	A	P	A	A	A	A	A	P
17	Teachers provide an opportunity for real world applications	P	A	P	P	P	A	A	A	A	P	A	P	A	A	P	A	A	A	A	P	A
18	Improved communication skills	P	A	A	P	P	P	P	A	A	P	A	A	P	A	P	A	A	P	P	A	A

Table 4.27: GK-12 Draft Coding Sheet: Rater 6

	Characteristics	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u
1	Teachers' discipline-specific knowledge is increased	A	A	P	A	P	P	P	A	A	P	A	A	P	A	P	A	A	A	A	P	P
2	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.	A	A	P	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A
3	Teachers understand how students learn and what are effective teaching strategies.	A	A	P	A	A	A	A	A	A	A	P	A	P	A	P	A	A	A	A	P	A
4	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	P	A
5	Requires resources (money and time)	P	P	P	P	P	P	P	P	A	P	P	A	P	P	P	A	A	P	P	P	P
6	Professional development is on-going	P	A	P	A	A	A	A	A	A	A	P	A	P	A	P	A	A	P	A	P	P
7	Professional development occurs in day-to-day contexts of teachers	A	A	P	P	A	A	A	P	A	P	P	A	P	A	A	A	A	P	P	P	P
8	Uses effective teaching strategies	A	A	P	A	P	A	A	A	A	A	P	A	P	P	P	P	A	A	A	P	P
9	Coherent/aligned with school/district/state goals	A	A	A	A	P	A	A	A	A	P	P	A	P	A	A	A	P	A	P	A	A
10	Teachers provide input into professional development design; professional development is engaging and relevant	A	A	P	A	A	A	A	P	A	A	A	A	P	A	A	A	A	A	P	A	A
11	Involves collaboration between teachers and others	A	P	P	P	P	P	P	A	A	P	P	A	P	P	A	P	A	P	P	P	P
12	Generates further collaboration or projects	A	P	A	P	P	A	A	P	A	A	P	P	A	A	A	A	A	P	A	A	P
13	Treats teachers as professionals	A	P	P	P	P	P	P	P	A	P	P	A	P	P	P	A	A	P	P	P	P
14	Promotes teacher self-reflection	A	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A
15	Uses inquiry as a teaching style	A	A	P	A	A	A	A	A	A	A	P	A	A	P	A	A	A	A	A	P	A
16	Increases teacher ability to meet needs of diverse learners	A	A	P	A	A	A	A	A	A	P	A	A	A	A	P	A	A	P	A	A	P
17	Teachers provide an opportunity for real world applications	A	A	A	P	P	A	A	A	A	P	P	P	A	A	P	A	A	A	A	A	A
18	Improved communication skills	P	A	A	A	P	P	P	P	A	P	A	A	P	A	P	A	A	P	P	A	A

Table 4.28: Draft Coding Sheet, Inter-rater Reliability: Rater 5

	Characteristics	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	K
1	Teachers' discipline-specific knowledge is increased	A	A	P	P	P	A	P	A	A	P	A	A	P	A	P	A	A	P	P	P	P	1
2	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.	A	A	A	P	P	A	A	A	A	P	P	A	A	P	A	A	A	A	P	P	A	0.89
3	Teachers understand how students learn and what are effective teaching strategies.	A	A	P	A	A	P	A	A	A	A	P	A	P	A	A	A	A	P	P	P	P	0.90
4	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.	A	A	A	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	1
5	Requires resources (money and time)	P	P	P	P	P	P	P	P	A	P	P	P	P	P	P	P	P	P	P	P	P	1
6	Professional development is on-going	A	A	P	P	P	A	A	P	A	P	P	A	P	A	P	P	A	P	P	P	P	1
7	Professional development occurs in day-to-day contexts of teachers	A	A	P	P	P	P	P	A	A	P	A	P	P	P	P	A	A	P	P	P	P	1
8	Uses effective teaching strategies	A	A	A	A	A	P	A	A	A	A	P	A	P	A	A	A	A	P	P	P	A	0.89
9	Coherent/aligned with school/district/state goals	P	A	A	P	P	A	A	A	P	P	P	A	A	A	A	A	P	A	A	A	A	0.89
10	Teachers provide input into professional development design; professional development is engaging and relevant	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	1
11	Involves collaboration between teachers and others	P	A	P	P	P	A	P	P	A	P	A	A	P	A	P	A	A	P	P	P	P	1
12	Generates further collaboration or projects	A	A	P	P	P	A	A	A	A	A	P	A	A	A	A	A	A	P	A	A	P	0.89
13	Treats teachers as professionals	A	A	P	P	P	A	P	P	A	P	A	A	P	A	A	A	A	P	P	P	P	1
14	Promotes teacher self-reflection	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	1
15	Uses inquiry as a teaching style	A	A	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	P	A	0.46
16	Increases teacher ability to meet needs of diverse learners	A	A	A	A	A	P	P	A	A	A	A	A	A	A	P	A	A	A	A	A	P	0.86
17	Teachers provide an opportunity for real world applications	P	A	P	P	P	A	A	A	A	P	A	P	A	A	P	A	A	A	A	P	A	1
18	Improved communication skills	P	A	A	P	P	P	P	A	A	P	A	A	P	A	P	A	A	P	P	A	A	0.90

Table 4.29: GK-12 Draft Coding Sheet, Inter-rater Reliability Differences: Rater 5

	Characteristics	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u
1	Teachers' discipline-specific knowledge is increased																					
2	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.							*														
3	Teachers understand how students learn and what are effective teaching strategies.	*																				
4	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.																					
5	Requires resources (money and time)																					
6	Professional development is on-going																					
7	Professional development occurs in day-to-day contexts of teachers																					
8	Uses effective teaching strategies									*												
9	Coherent/aligned with school/district/state goals									*												
10	Teachers provide input into professional development design; professional development is engaging and relevant																					
11	Involves collaboration between teachers and others																					
12	Generates further collaboration or projects																			*		
13	Treats teachers as professionals																					
14	Promotes teacher self-reflection																					
15	Uses inquiry as a teaching style								*													
16	Increases teacher ability to meet needs of diverse learners																			*		
17	Teachers provide an opportunity for real world applications																					
18	Improved communication skills																			*		

Table 4.30: GK-12 Draft Coding Sheet, Inter-rater Reliability: Rater 6

	Characteristics	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	K
1	Teachers' discipline-specific knowledge is increased	A	A	P	A	P	P	P	A	A	P	A	A	P	A	P	A	A	A	A	P	P	1
2	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.	A	A	P	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	1
3	Teachers understand how students learn and what are effective teaching strategies.	A	A	P	A	A	A	A	A	A	A	P	A	P	A	P	A	A	A	A	P	A	0.86
4	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	P	A	1
5	Requires resources (money and time)	P	P	P	P	P	P	P	P	A	P	P	A	P	P	P	A	A	P	P	P	P	0.86
6	Professional development is on-going	P	A	P	A	A	A	A	A	A	A	P	A	P	A	P	A	A	P	A	P	P	0.90
7	Professional development occurs in day-to-day contexts of teachers	A	A	P	P	A	A	A	P	A	P	P	A	P	A	A	A	A	P	P	P	P	0.90
8	Uses effective teaching strategies	A	A	P	A	P	A	A	A	A	A	P	A	P	P	P	P	A	A	A	P	P	1
9	Coherent/aligned with school/district/state goals	A	A	A	A	P	A	A	A	A	P	P	A	P	A	A	A	P	A	P	A	A	1
10	Teachers provide input into professional development design; professional development is engaging and relevant	A	A	P	A	A	A	A	P	A	A	A	A	P	A	A	A	A	A	P	A	A	0.86
11	Involves collaboration between teachers and others	A	P	P	P	P	P	P	A	A	P	P	A	P	P	A	P	A	P	P	P	P	0.89
12	Generates further collaboration or projects	A	P	A	P	P	A	A	P	A	A	P	P	A	A	A	A	A	P	A	A	P	1
13	Treats teachers as professionals	A	P	P	P	P	P	P	P	A	P	P	A	P	P	P	A	A	P	P	P	P	1
14	Promotes teacher self-reflection	A	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	1
15	Uses inquiry as a teaching style	A	A	P	A	A	A	A	A	A	A	P	A	A	P	A	A	A	A	A	P	A	0.86
16	Increases teacher ability to meet needs of diverse learners	A	A	P	A	A	A	A	A	A	P	A	A	A	A	P	A	A	P	A	A	P	1
17	Teachers provide an opportunity for real world applications	A	A	A	P	P	A	A	A	A	P	P	P	A	A	P	A	A	A	A	A	A	1
18	Improved communication skills	P	A	A	A	P	P	P	P	A	P	A	A	P	A	P	A	A	P	P	A	A	0.90

Table 4.31: GK-12 Draft Coding Sheet, Inter-rater Reliability Differences: Rater 6

	Characteristics	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u
1	Teachers' discipline-specific knowledge is increased																					
2	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.																					
3	Teachers understand how students learn and what are effective teaching strategies.			*																		
4	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.																					
5	Requires resources (money and time)				*																	
6	Professional development is on-going																					
7	Professional development occurs in day-to-day contexts of teachers					*																
8	Uses effective teaching strategies																					
9	Coherent/aligned with school/district/state goals																					
10	Teachers provide input into professional development design; professional development is engaging and relevant	*																				
11	Involves collaboration between teachers and others													*								
12	Generates further collaboration or projects																					
13	Treats teachers as professionals																					
14	Promotes teacher self-reflection																					
15	Uses inquiry as a teaching style																					
16	Increases teacher ability to meet needs of diverse learners				*																	
17	Teachers provide an opportunity for real world applications																					
18	Improved communication skills														*							

Table 4.32: GK-12 Draft-Coding Sheet Reliability Changes, Raters 5 and 6

	Characteristics	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u
1	Teachers' discipline-specific knowledge is increased				A														P	A		
2	Teachers understand how students learn and what are effective teaching strategies within a specific discipline.			A							A				A	A				A	N	
3	Teachers understand how students learn and what are effective teaching strategies.				A		A									P			A	P		N
4	Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked.			A		A															P	
5	Requires resources (money and time)												N				N	N				
6	Professional development is on-going	P				A	P		A		P						A			A		
7	Professional development occurs in day-to-day contexts of teachers				P	A	P	A	A			P	A		A	A						
8	Uses effective teaching strategies			P			A								P	P	P		A	A		P
9	Coherent/aligned with school/district/state goals	P								P				P				P		A		
10	Teachers provide input into professional development design; professional development is engaging and relevant								P					P						P		
11	Involves collaboration between teachers and others	A	A				P		A			P			A	A	P					
12	Generates further collaboration or projects		A	A	A				P				A				A					
13	Treats teachers as professionals		P				P					P			P	P						
14	Promotes teacher self-reflection													P								
15	Uses inquiry as a teaching style			A								P										
16	Increases teacher ability to meet needs of diverse learners			P			N	P			A								A			
17	Teacher provide an opportunity for real world application	P		P	P							P									A	
18	Improved communication skills								P													

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VITA

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